

HUMAN AND ANIMAL VARIOLÆ:

A STUDY IN COMPARATIVE PATHOLOGY.

BY

GEORGE FLEMING, F.R.C.V.S.,
C

ARMY VETERINARY INSPECTOR;

PRESIDENT, ROYAL COLLEGE OF VETERINARY SURGEONS.



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PREFATORY NOTE.

THE following study is, I believe, the first attempt to deal with the subject of Variola from a comparative pathologist's point of view, in the English language. The very little that is evidently known in this country with regard to the variolous affections of animals, and the erroneous notions that prevail with regard to them—as was demonstrated at the Vaccination Conference recently held in London—induced me to take up their investigation. A portion of the inquiry was published from time to time in the *Lancet*, and subsequently this was amplified in the VETERINARY JOURNAL, which I edit. In the present form the study is completed, and will, I trust, form a small contribution to the literature of a subject full of interest and importance.

G. FLEMING, F.R.C.V.S.

War Office,

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BY GEORGE FLEMING, F.R.C.V.S., ARMY VETERINARY INSPECTOR.

THE recent conference held in London on Animal Vaccination will not have been without a useful result, if it has been the means of not only drawing attention to this particular subject, but also to the very meagre knowledge we seem to possess with regard to Variola in animals, and, indeed, of all animal disorders which are communicable to mankind, and *vice versâ*. The discussions which took place at the meetings of the conference afforded another proof of the necessity of instituting what I have for years maintained should form a branch of medical study—a chair of Comparative Pathology at each of our medical schools. Surely a knowledge of animal diseases, in their relation to those of our own species, is of far more moment to the surgeon or physician in the practice of his profession, than an acquaintance with zoology or comparative anatomy. Such chairs are established in nearly all, if not all, Continental medical schools, in which their value has long been recognised. Why is it, then, that we are so slow or so unwilling to adopt what is so manifestly and so urgently required in order to complete the student's education, and to render him a more useful and enlightened member of society?

From the opinions expressed at the conference, as well as elsewhere, I gather that the view is largely entertained among medical men in this country, that human and bovine Variola, or Vaccinia, are one and the same disease: the latter being dependent for its origin and maintenance upon the former, though undergoing a certain and special modification in the passage of its virus through the organism of the ox; so that, when re-transplanted in the human species, it is no longer Small-pox, though it offers protection, partially or wholly, permanently or temporarily, against an attack of that malady.

It would also appear to have been accepted by those present at the conference, that there are only two distinct kinds of Variola—one affecting man, the other sheep. And one opponent of animal vaccination, in dwelling upon the dangers likely to attend that operation, pointed out the existence of several diseases which, he asserted, bovines are liable to, and which he would lead us to infer might be communicated to those vaccinated direct from the calf. Among the diseases he enumerated were Contagious Pleuropneumonia, Anthrax, Glanders, certain disorders due to helminths, and "Entozootic Asthma."

Now, without at present claiming to be a supporter of animal vaccination, I may as well state that the apprehended danger from these disorders is more

* Reprinted from the *Lancet*.

or less purely imaginary. Contagious Pleuro-pneumonia is peculiar to cattle, and cannot be transmitted in any form to other species, not even by direct inoculation of its morbid products ; Glanders is not a bovine disease, and all attempts to convey it to the ox tribe have invariably failed ; Anthrax runs its course too rapidly, and is too marked a disease to be considered in connection with animal vaccination ; the worm disorders have no relation to the subject under discussion ; while as for "Entozootic Asthma," why, I never heard of it before, and I fancy nobody else, so that it may also be dismissed as unworthy of consideration. Candidly speaking, if I anticipated any danger in animal vaccination, from the presence of constitutional disease in the vaccinated calf—which I do not at present—I would rather be inclined to look upon the existence of Tuberculosis with some suspicion ; but this serious malady the speaker did not refer to. There is, however, no evidence that it can be conveyed to mankind by retro-vaccination ; and, to my mind, the risk is so infinitesimal, considering that the calf is so rarely affected with the disease, at least in an active form, that I think it may not be taken into account just now.

Of infinitely greater importance is the relationship between human Small-pox and Cow-pox, which was treated as a merely collateral subject at the conference, but was, nevertheless, made the occasion for some strong opinions being expressed as to the absolute identity of the two maladies. The solution of the problem as to whether Small-pox and Cow-pox are one and the same disease, modified only in their manifestation by differences in the organism of man and the ox, or whether they are distinct and independent disorders, having only a family or generic resemblance, well deserves the most serious efforts ; constituting, as it does, a question of the very highest scientific and practical interest, and one about which there should be nothing speculative. Its practical aspect more particularly invites examination, for if it be demonstrated that the two are identical, the Cow-pox being derived from Small-pox, then there is no occasion to hesitate as to the selection of vaccine lymph ; for we might, without compunction, take that which is directly elaborated in cows through inoculation with the Small-pox matter of man, and thus save all the search and precautions at present imposed upon us in order to obtain a vaccine fluid which shall be innocuous, and at the same time sufficiently potent to afford protection from Variola. But if, on the contrary, the Small-pox communicated to the cow retains all its characters, and when again transferred to mankind merely reproduces itself in its dangerous, general eruptive and highly infectious form, then recourse to variolo-vaccination would be a serious and reprehensible step, and one which should be opposed. Or if the Small-pox virus, in passing through the cow, should still retain its Variola-producing attributes, but yet become so subdued as to be as harmless, and still as effective as vaccine, ought it to take the place of the latter altogether, or should it be employed simply as an auxiliary ? These questions have been asked before, and I venture to ask them again, as a reply to them is of the greatest moment at this particular time, not only in regard to Small-pox, but to other virulent affections. For

if, notwithstanding the apparent differences in their characters, the human and bovine diseases are the same in nature, the virus only being beneficially modified or transformed by transference from the one creature to the other, it gives us reason to hope that the virulent principle of other contagious scourges which only attack once in a lifetime, may be similarly attenuated by emigration from one species of animal to another, and still retain its protective influence. But if the human and the cow disease are due to a different virus, and the one has power to neutralise the other, the reciprocal neutralisation being greatly to the advantage of the creatures concerned, then also there is good reason for hoping that with other contagious maladies of the same, or even a different type, there may be discovered a similar means of destroying their germinative power.

Notwithstanding the immense importance of the question, the long time that has elapsed since vaccination was introduced, the multitude of works upon the diseases, and the great opportunities that have been afforded for clinical and experimental observation, it is indeed astonishing to find opinions still divided on the subject of human and animal Variolæ and their relationship. Strange it is to note doubt and hesitation, and unfruitful discussions as to the nature, advantages, and dangers of vaccination, when we reflect that it has been practised for ninety years, and is universally adopted all over the world as a prophylactic against one of the direst of the pestilences which haunt the human family.

But so it is ; and, as before observed, the tendency among medical men, at least in this country, appears to be in favour of Small-pox and Cow-pox being due to one and the same virus ; in opposition to the Jennerian doctrine, that the Cow-pox was derived from Horse-pox, and had none but an antagonistic relationship to human Variola. Their belief seems to be founded on the reports of certain experiments performed by four or five persons (Gassner, Thiele, Sonderland, Badcock, Ceely), in which positive results were obtained some forty or fifty years ago, and on accounts of a few instances in which Small-pox was said to have been communicated from sick people to animals. Jenner, according to this opinion, was mistaken ; his Cow-pox was not derived from "greasy-legged" horses, but from the Small-pox-stricken people who went about and handled the milch cows, and so infected or inoculated them. It follows that only cows were (and are now) affected ; that Cow-pox was much more prevalent in those days than now, because Small-pox was more prevalent ; that only mankind and sheep have a distinct Variola of their own, for the simple reason that those who entertain this opinion never saw or heard of any other species being affected with Variola ; that failures in recent attempts to produce Cow-pox, by inoculating cattle with Small-pox virus, and the production of Small-pox when the matter of the eruption was transferred from the cows to children, were due to the human virus being merely deposited in a little pouch in the animal's skin, where it did not undergo the supposed modification ; and that, though all recent experimenters have failed in developing Cow-pox from Small-pox, yet at the period mentioned it was accomplished without difficulty.

Deeply impressed with the vast importance of arriving at the truth in such a grave question, I have for many years devoted much attention to it, and have already done what in me lay to settle it : at least so far as the Variolæ of animals are concerned, as will be seen on referring to my work on "Veterinary Sanitary Science and Police" (vol. ii., p. 28) ; and I will now venture to dispute every one of the arguments brought forward to prove that human Variola and Cow-pox are due to the same virus, or are the same disease ; or that there are only Small-pox and Sheep-pox as distinct Variolæ. With regard to animals, I may at once state that I believe every species has its own independent and particular kind of Variola, and I am unable to understand why man and the sheep should alone have the unhappy privilege of being the special subjects of different forms, and this privilege be denied to all the other creatures.

Whether these forms may have been originally derived from a common or primitive source or type, I will not now stop to inquire ; but that they exist and compose a group of diseases rather than one malady, cannot be matter for doubt. That they more or less widely differ from each other, that in each species each form has a special character, and though that which is particular to one species may be transmitted to another species, yet the Variola of this species need be scarcely a subject for dispute ; while the fact that their differences are marked, not only with regard to their particular features, but also as to their capability of transference to other species, and their antagonism to each other, has been clearly demonstrated. Admitting that which I shall presently attempt to prove, that the cow has its own Variola, we know that when this is communicated to man it does not produce Small-pox, though it protects from it. The Sheep-pox has been inoculated on man by many experimenters—among others, by Marchalli, Sacco, Voison, and Hering, but only a small localised group of pustules, quite unlike the eruption of ovine Variola, has appeared at the seat of inoculation, and no protection from Small-pox or Vaccinia has been conferred. Neither human Variola or yet Vaccinia will give rise to Sheep-pox, neither will their inoculation protect the sheep from its own Variola. Horse-pox is communicable to the cow and mankind, and protects them from their Variolæ, as well as the human species from Vaccinia, while vaccination protects the horse from its Pox. As we shall see immediately, though the virus of human Small-pox, when deposited in the skin of the cow, does give rise to a local papulation—often very trifling, exceptionally very marked—yet this is not the regular eruption of Cow-pox, either in its appearance or course, and it does not prevent the cow being successfully vaccinated at the same time, though it appears to destroy the aptitude to receive Vaccinia ; while in two or three transmissions through the bovine species it becomes altogether impotent. The same results are observed in the horse, which, however, appears to receive the virus of human Small-pox more readily, and to exhibit more marked local phenomena than the ox ; while this inoculation also protects it partially, if not entirely, from the action of vaccine virus, which it otherwise so readily receives. As in the ox likewise, the Small-pox virus soon loses its potency in being carried from

one animal to another—it cannot be cultivated in them ; and experiment has demonstrated, that no more in the organism of the horse than in that of the ox can human Variola be transmuted, but that after passing through the bodies of solipeds, and again transferred to man, it has lost none of its characteristic features.

Cow-pox can be very readily transferred to man, the ox, horse, and goat, the first three showing an equal aptitude for its reception ; in them also the transmission of the disease is indefinite—*i.e.*, the virus may be cultivated, without impairment, for a limitless number of generations, and it confers immunity against the Variola of man and the horse, while the ox itself is protected. But while vaccination only produces in man and the ox a local and limited eruption, in the horse it often produces a startling pustular exanthem, which, in character and seat, differs in nothing from natural Horse-pox. Another peculiarity in the action of the vaccine virus in the horse is its tendency to produce this vaccinal eruption, and at the same time to confer immunity, when introduced directly into the lymphatics or blood-vessels ; while in the ox it does neither under this condition—all circumstances which would lend support to the opinion of Jenner, that the horse is really the true source of natural Vaccinia.

Vaccination in the dog usually only produces small red nodules at the punctures, but nothing at all resembling the vaccinal eruption. It is the same with the pig. In the sheep a small papule generally forms at the seat of inoculation, with rarely a little vesicle that rapidly becomes encrusted. Revaccination from this to calves gives negative results.

Not only in their special characters do the Variolæ of man and animals differ, but also in their apparent mode of extension. Human Variola and Sheep-pox differ widely from each other in some respects, particularly in their not acting antagonistically, and in the appearance of the eruption, but they are identical so far as their diffusion is concerned. They are both infectious and contagious, and can be transmitted by fomites, as well as by actual contact ; while their virus possesses a vital resistance somewhat remarkable. Cow-pox, Horse-pox, and the Variolæ of other animals would appear to depend for their dissemination upon their contagious properties only, and their virus readily becomes deteriorated.

There are other peculiarities in the Variolæ of man and animals which still further differentiate them, but these I shall not allude to here ; so pass on to the consideration of the far more pressing question as to the identity of Small-pox and Cow-pox, and an examination of the arguments brought forward in support of this identity. But before doing so, I may as well confess that I do not for a moment hold with the abiogenetic or “spontaneous” origin of Variola either in man or beast, and am prepared to maintain that whenever and wherever, and in whatever species the disease manifests itself, it is always due to its own special contagium, no matter how this may be conveyed.

It has been stated that Cow-pox is now a very rare disease, and that the probable cause for its being more frequent in the days of Jenner was the

much greater prevalence of Small-pox ; thus leading to the inference that the one disease was dependent on the presence of the other. But this statement will not bear close examination. We have no definite evidence to prove that Cow-pox was a common disease before vaccination became general, nor yet that it is a very rare malady now ; still less that its frequency had any relation to the occurrence of Small-pox. We have only the testimony of Jenner, and two or three other observers of the early part of this century, and they may have witnessed merely local outbreaks, such as occur now and again in different countries. It appears to have been known from time immemorial, and was certainly so in India, Persia, South America, and the continent of Europe long before the time of Jenner. But it had not been studied until Jenner's discovery, and its presence may have often been overlooked, or it may have been confounded with other bovine disorders. Soon after the announcement of the protective influence of vaccination on man, Cow-pox was sought for and found at Castres, Nancy, Metz, Strasbourg, and Rambouillet, in France, as well as in various parts of Italy, Prussia, Spain, Wurtemberg, Holstein, Denmark, and elsewhere in Europe. That Cow-pox did appear, and that it was, perhaps, somewhat common in that part of Gloucestershire in which Jenner resided, and indeed in many places in England, is not at all denied ; but that its prevalence was owing to Small-pox being rife, is opposed to all clinical and experimental evidence. Small-pox is transmitted with difficulty to the cow, and does not produce Cow-pox, as I have already asserted. If Cow-pox was more common a century ago than at present, this may be due to the greater care bestowed upon cattle in their dwellings, and more general good management now than formerly. Dairies are kept cleaner and more wholesome, and people who milk and go among cows are more proper in their own persons than they probably were years ago ; consequently, if a case of Cow-pox does appear, it has not the same facilities for transmission to other cows. This transmission appears to be mainly effected by the milker ; the vesicles, being chiefly localised on the udder or teats, are ruptured in the act of milking, and the virus on the dairymaid's hands is transplanted to the lacteal apparatus of the cows she next milks. Sores are frequent on the teats, and the presence of these renders vaccination all the more certain. It is very unlikely that people affected with Small-pox would work in dairies, and still more unlikely, if they did so, that they would infect the cows. If Cow-pox could be produced through the medium of diseased dairymaids, it ought to be more common now than before vaccination was introduced, seeing the great difficulty with which Small-pox is transferred to the cow (when it does not produce Vaccinia), and the readiness with which this animal is vaccinated.

If Small-pox could accidentally give rise to Cow-pox, surely evidence of this would be forthcoming at the present day, when we have frequent, severe, and extensive outbreaks. There are certainly instances recorded of this so-called accidental transmission, observed many years ago, as well as coincident outbreaks of Cow-pox in localities where Variola was prevalent ; but these instances are so very few, and depend, seemingly, upon such a mere

chance, that they cannot be accepted as affording reliable proof of the actual possibility of such transmission ; while the fact that Small-pox prevails intensely over wide districts at times, without Variola being observed in the bovine or other animal species, as well as the other fact, that Cow-pox is observed here and there—individually, sporadically, enzoötically, and even epizoötically—without, however, Small-pox being observed, goes far to negative the likelihood of accidental transmission.

That Cow-pox may be a less frequent disease in this country than formerly, is quite possible, and, for the above reasons, very probable ; though in this respect England would not be an exception, for the veterinary professor, Spinola, mentions that it was a somewhat common malady towards the end of last century all over the German littoral of the Baltic, but to-day it is rare. Like all other diseases of this kind, however, it would appear to have its periods of subsidence and recrudescence. Neumann states that in Holland, in certain years, it was seldom seen, while in others—as in 1805, 1811, and 1824—it was rather frequent. Ritter says that in Schleswig-Holstein it is always present to some extent, but that in some years it assumes an epizoötic form, and is propagated from herd to herd—as in 1824, 1826, 1829, 1830, and 1832.

Now and again, too, we read of isolated outbreaks in different countries, which attract attention because of the large number of animals affected. The most recent of these is that recorded by Professors Oreste and Sabbatini in 1876 (*Gazetta Medico-Veterinaria*), as occurring among a herd of buffalos, more than two hundred of these animals, young and old, being attacked. The eruption in the cows was chiefly confined to the udder and teats, but the sucking-calves had it on the nose and lips. The pigs which consorted on the same pastures were not infected. The eruption was typical. According to the *Deutsche Zeitschrift für Thiermedizin* (December, 1879), Cow-pox appeared as an epizoöty in the summer of 1876, in the vicinity of Reykjavik, Iceland. It had never been seen there before, and caused very great alarm ; all the milch cows became progressively affected, and in several instances milkers got inoculated in the hands. Neither in this, nor any other of the outbreaks mentioned above, is any allusion made to Small-pox being prevalent in mankind.

In this country we have no means of arriving at any conclusion in regard to the extent to which it may prevail, as no reports are called for by Government, and veterinary surgeons are seldom, if ever, required to attend cases of Cow-pox, these being usually so trifling. Indeed, it is not at all improbable that many pass unperceived, and those observed are not mentioned by dairy-keepers or milkers, or they may look upon the eruption as analogous to that which is sometimes seen on the teats or udder after parturition. The vesicles are broken, too, almost before they are developed, in the act of milking, and the sores which result are considered to be only simple abrasions or fissures, so common in this region. Therefore it is that there are very few veterinary surgeons, even of those practising in the most populous cattle districts in this country, who have ever seen a case of Cow-pox. But we see no reason for

thinking that the malady is much less common here than elsewhere—say in Wurtemberg, where the Government reports, drawn up by district veterinary surgeons, are very full and complete, and where rewards are offered for every case of Cow-pox from which children can be vaccinated. According to Hering (*Repertorium für Thierheilkunde*), in Wurtemberg, during the ten years from 1827-37, there were sixty-nine cases out of eighty-four which furnished an excellent vaccine lymph, and 152 out of 208 cases in which the lymph did not yield such satisfactory results; making in all about thirty reported cases every year. In 1873, there were thirty-nine cases, from which fifty-two children were successfully vaccinated; the cases were most numerous in April (18), May (13), and June (8), and one instance of accidental infection was reported—a farmer's wife, who had milked a cow in which the pustules had arrived at maturity, had a vaccine vesicle on the thumb. In 1874, twenty-four cows and four heifers were reported, but complaints are made that the information with regard to these came too late to make many of them available for vaccination—the pocks being either in the last stage, or ruptured, and only sores remaining. Nevertheless, lymph was procured from twelve, and with this twenty-five to thirty children were successfully vaccinated. Some interesting details are given with regard to these cases of Cow-pox, one of which was an example of *Variola succinea*. Surgeon Löffler, of Rottenburg, received on April 20th, one of the heifers—a two-year-old animal, twenty-five to thirty weeks pregnant, and very healthy. On the two posterior teats of the right side were three fine pustules, and on the last teat of the left side was another. On opening these a yellowish glutinous fluid escaped. On the 23rd, new pustules appeared. The udder and teat were hot, and on the latter were several small and large oval pustules, each with a red areola. When opened there flowed a yellow thick lymph from them; there was a very small quantity of clear lymph at the end. Two children were inoculated by puncture, and an additional quantity of lymph mixed with tepid water, was poured into the wounds. In one child there were developed four perfect and fine (*Vollkommen schöne*) silver-hued pustules, and in the other child one pustule. From these two children five others were successfully vaccinated. Another similar case is related by Dr. Kieser, of Gmünd, in which the cow was three years and a half old, and yielded lymph with which three children were vaccinated, and from these a large number. The details of these cases are full of interest, but I cannot dwell upon them here. I may mention, however, that among the cows were two cases of *V. vacc. nigr.* In 1875, twenty-three cases of genuine, and seventeen of spurious Cow-pox were reported. Nine of the former yielded satisfactory inoculations in children, and the owners of the animals were consequently rewarded. One cow was reported to have shown a succession of genuine pocks for two years; it was seven years old, and was pregnant with the fifth calf. On the udder, on April 14th, were a number of pustules, from the size of a pea to that of a kreuzer, surrounded by a red border, and containing a partly watery-looking and partly milky-looking lymph. In the course of the next day the pustules became desiccated. On April 24th, four new pustules were seen, these soon became

encrusted, and were succeeded by others which were merely abortive pustules, and the case continued under observation for some time, not as one of Vaccinia, but as one of Chronic Pemphigus. In 1876 it is again complained that cows were only reported as affected with pock when they became visibly unwell, the secretion of milk diminished, and the teats so swollen and sore that milking was impossible. There were forty-six cases reported, twenty-one of which were genuine, and twenty-five spurious. Successful vaccinations were notified in a number of children, as well as some instances of accidental infection. One of the latter was a girl who daily milked a cow which had calved fourteen days previously; three teats of the animal had sores and pustules on them, and the girl inoculated her nose through scratching it while she was milking. In 1877 it was very prevalent, especially in July and August; in many cases difficulty was experienced in milking the cows, the mammæ often requiring to be relieved artificially, and Mammitis being frequently observed as a complication. Several cases were timeously reported, and accidental inoculation of people was noted. In the ambulatory clinic of the veterinary school there were 106 cows affected with ordinary Cow-pox during the year, and eleven with the tubercular or nodular form (*Knotenförmigen*). In 1878 thirty-six cows and two calves were reported, but in consequence of reaching them at an unfavourable period, lymph was collected by the district veterinarians from only five cases; this was successfully utilised. The Minister of the Interior had offered a reward of twenty-four marks to owners of cattle for every animal they timeously reported as suffering from Cow-pox.

None of the other German States include this disease in their reports. Belgium has issued recently a Health Report of Animals ("Etat Sanitaire des Animaux Domestiques"), published in the Bulletin of the Conseil Supérieur d'Agriculture. In that for 1877, I find that at Châtelet there was an outbreak of Vaccinia among dairy cows; but when the veterinary surgeon saw them the attack was subsiding, and on the cows still affected the pustules were either broken or dried up. Before the eruption appeared the cows gave an abundance of milk, and were grazing in the fields. At Wommen a large number of cattle were affected with Vaccinia, and the same reporter mentions pigs as being affected with Variola in the same district.

Cow-pox appears in the Danish Health of Animals returns; and I observe that in 1875 there were included in the returns twenty-six cases of natural Cow-pox throughout Norway, while in 1878 there were reported 581 cases in sixty-nine localities, forty-five of these being in Northern Seeland. They occurred, as in other countries, all the year round, but were most numerous towards September.

I have taken the liberty of bringing forward this evidence to prove that Cow-pox is not an extinct disease; that the chance cases reported in such small countries as Wurtemberg, Belgium, and Denmark amount to a considerable number in the course of the year; that there is ample clinical and experimental proof that the malady is really Vaccinia, and has no relation whatever to human Variola; that the presence of the disease in isolated

cases, or in a sporadic condition, gives it the power of assuming an epizootic form when circumstances permit ; and that, although it is more or less denied that Cow-pox exists in this country, there is every probability that it is at least quite as common as in Wurtemberg, though perhaps less so than in the days of Jenner.

With regard to the localisation of the disease in the cow, it is quite true that the mammæ and teats are the special seat of the eruption, just as the mouth, lips, and limbs are the ordinary situation of the Horse-pox. Nevertheless, cases now and again occur in which, as also in the horse, the eruption is not limited to the usual parts, but appears on the muffle, nostrils, and other regions where the skin is thin and the hair scanty. Pilger, D'Arboval, and other veterinarians testify to this, as also do the Wurtemberg reports. But the eruption is very far from being general over the body, even in these instances.

The female sex of the animal has been brought forward as an argument in favour of Cow-pox being communicated by the hands of persons affected with Small-pox. But it is quite forgotten that there are more cows than bulls or bullocks ; that they are generally completely under observation in cowsheds ; that when in milk their teats are constantly handled, and therefore the eruption can be felt and seen, while inoculation from cow to cow is made all the more easy, and the disease, consequently, much more diffused than it would otherwise be. With the bull or the bullock, on the contrary, there are none of these opportunities for observation or extending the contagion. The bull is seldom indeed with the cows, and then only for a brief period ; while the parts which might be the seat of eruption are rarely handled, and perhaps never examined. The bullock is still less, perhaps, exposed to contagion or submitted to examination. But I entertain no doubt whatever that both the bull and the bullock do suffer from Vaccinia, and it is quite ridiculous to imagine they do not. Male bovines have been largely employed in vaccination experiments on the Continent, and the vaccine lymph has acted as promptly and effectively on them as on the cow. At Bâle, the veterinarian, Sigismund, for a long time furnished the vaccinators with lymph cultivated on bulls which were intended for slaughter ; he inoculated them on the scrotum. Chauveau has also successfully vaccinated bulls, and so have other experimenters. Roloff, of the Berlin Veterinary School, has demonstrated how easily the bull could be infected. He slightly abraded the skin of the scrotum, and gently rubbed the vaccine lymph upon it ; the characteristic eruption took place in due course. If bulls or bullocks stood in cattle-sheds with an equal number of cows, and were treated and exposed to contagion in the same way as these, there is every probability that we should have bull or bullock-pox frequently enough. Where this association is allowed to take place on the Continent, bulls and bullocks are infected. An interesting case of this kind is recorded in the *Repertorium für Thierheilkunde* for 1879. A bull, two-and-a-half years old, is there described as affected with Vaccinia, the pustules and crusts being situated on the scrotum, a hind and fore foot, and lips. The animal suffered a good deal. The lymph from the

pustules was employed with success in the vaccination of children. So that it is simple nonsense to assert that the male bovine is exempt from Vaccinia; and it betrays ignorance of what has been observed by competent men, as well as lack of knowledge of pathology in general and this disease in particular.

What we might call the *casual evidence* as to the non-identity between human Variola and Cow-pox, and their being two distinct diseases of a group, is still further increased by other facts which may be mentioned. The individuality of contagious maladies is, perhaps, never more strongly marked than when we find two affecting the same person or animal, and running their course concurrently, the various phases of one being passed through entirely independently of the evolution of the other. Such instances are far from infrequent in the practice of the physician and veterinary surgeon, and from my own experience I could relate several. But I refrain from doing so, as additional testimony of this kind is not required at this period of the nineteenth century, I hope. But in the discussion now undergoing consideration, such evidence should be borne in mind when we mention the fact, that cases are recorded in which people already infected with Small-pox, and who had been vaccinated when so infected, have had the eruptions of the two diseases apparent at the same time, each preserving its special characters, undergoing its different changes, and terminating exactly as if it were totally independent of the other, and had not the slightest influence in modifying or checking its course. And more than this, Hallé is reported to have employed the lymph from vaccine vesicles developed under these conditions, to vaccinate healthy children, and has only produced the pock of Vaccinia—never Small-pox. In one of Chauveau's experiments, in which a horse was inoculated with the virus of human Small-pox, which gave rise to local effects, and was also inoculated with vaccine lymph, evidence of the two morbid actions operating coincidently was undeniable, and afforded one more proof that a certain lapse of time must ensue before the preservative influence of vaccination comes into play.

However strong and abundant clinical and casual evidence may be, it is not always completely convincing, unless supported by experimental demonstration, when it is then irresistible. This evidence is also fortunately at hand, and in a most exhaustive and complete form; and it is very remarkable that, with the exception of one speaker at the conference (Dr. Cameron), its existence does not seem to have been known to those present; at least, this may be inferred from the circumstance that it was never alluded to, save in the one instance mentioned. That my surmise is not very wide of the truth, may be taken for granted, when we read of one gentleman saying, in reference to the experiments conducted by my friend, Professor Chauveau, of the Lyons Veterinary School, and briefly summarised by Dr. Cameron, that "it seemed strange that men should, at the present time, go abroad to France, to the futile and speculative experiments of a Frenchman, and take possession of the inferences he entertained." Such language betokens either ignorance of, or an utter failure to appreciate, the value of the results of these experiments; but then this speaker asserted that he had success-

fully inoculated a large number of cows with Small-pox virus, and produced *Vaccinia* which gave him abundant vaccine lymph.

In France, as in some other European countries, the origin of Cow-pox had long been a fruitful subject for discussion and speculation, and more than once it had provoked warm debates at the Paris Academy of Medicine. In 1863, M. Bouley, then director of the Alfort Veterinary School, had re-discovered at Paris the "Horse-pox" of Dr. Loy, of Pickering—in reality, the "Grease" of Jenner, Sacco, and others, who believed in the equine origin of Cow-pox. But M. Depaul, who had also, with Bouley, studied this *vaccinogenous* disease of the horse, was inclined to follow the example of Baron and his followers, and to conclude that it and all other eruptive disorders occurring in animals, and possessing analogous characters, were nothing more nor less than human Variola. So it was that he included Sheep-pox, and the aphthous disorder of animals known as Foot-and-mouth Disease, in the list of disorders having their common source in Small-pox. The influence which he and Bouley possessed divided the Academy into two camps, and the result was recourse to experimentation, which happily led to the conclusion that this equine eruption was capable of producing Cow-pox in the cow and *Vaccinia* in mankind. But the burning question as to the identity of Small-pox and the diverse varioliform affections of animals remained as undecided as before ; no new facts of a reliable kind were brought forward, and there was nothing to talk about save the well-known contradictory circumstances which had been so often alluded to before, but which were again brought into debate with all the oratorical ability and scientific ardour for which that renowned body is remarkable. Viewing it as a purely experimental matter, as a question which could only be decided by true facts, the Society of Medical Sciences of Lyons appointed a commission to carry out this inquiry. The commission was composed of Drs. Boudet, Delore, Dupuis, Gailleton, Horand, Lortet, Meynet, and Viennois, and the veterinary professor Chauveau. The latter was the president of the commission, and on him chiefly devolved the task of experimenting on the animals. A man more competent for the onerous duty imposed upon him could not be found in Europe ; his reputation in the world of medical science stands very high as a most accomplished physiologist and experimental pathologist, the results of whose experiments may be received as absolutely trustworthy. Drs. Viennois and Meynet were secretaries, and the three drew up the final report, which was presented in 1865. On March 5th, 1866, the French Academy of Sciences awarded the Montyon prize, value 2,500 francs, to Chauveau and his two colleagues, Viennois and Meynet, and gave honourable mention to the other members of the commission. This award was made on the recommendation of a commission appointed by the Academy, and constituted by such men as Claude Bernard, Serres, Velpeau, Cloquet, Joubert, Flourens, Rayer, Milne Edwards, and Longet, who gave their opinion as to the great interest and value of the Lyons investigations. This commission, aware that the medical profession had been divided in opinion as to whether, if human Variola were inoculated on the cow, it could

be so modified as to produce true primary Vaccinia, or whether Variola was so foreign to the bovine species that its inoculation in cattle was impossible, alludes to the ability of Chauveau, and to the results of his labours, which demonstrated that the truth lay on neither side. These results proved that human Variola could be inoculated on the cow and horse with the same certainty as Vaccinia ; but they also showed, contrary to what takes place in the human subject, that the primary effects produced by inoculation with the two viruses were absolutely different. Thus, with the ox, the Small-pox virus only determines a local eruption of papules, often so small that they would pass unperceived if one were not warned of their existence. Hence the mistake made by some experimenters, who have denied that Small-pox could be inoculated on bovines. The vaccine virus, on the other hand, engenders the typical pustular eruption, with its large characteristic *boutons*.

Analogous differences are observed, continue the Academy commissioners, on animals of the equine species. These differences are still more manifest in the same animal inoculated simultaneously with the two viruses : the two eruptions are then developed simultaneously without appearing to influence each other, and preserve their special characters. But the two viruses are not less capable of acting one on the other, and so reciprocally neutralising each other—just as in man—when inoculated successively on the same animal. In fact, human Small-pox generally fails on vaccinated animals, while the vaccine virus as commonly fails on those which have been previously submitted to variolous inoculation. In no case had Chauveau and his colleagues seen the slightest tendency to *rapprochement* between the characters of the two eruptions in the horse and ox. In attempting to cultivate the variolic virus on these two species, they have even discovered that it cannot become acclimatised in them, and that, with the ox in particular, it becomes impotent at the second or third generation ; while the vaccine disease is propagated indefinitely from one individual to another. With regard to the inoculation of man with this variolic virus which had been transiently (*passagèment*) implanted in the organism of animals, this only engenders Small-pox, neither more nor less, just as does the variolous virus obtained direct from the human species. The eruption is sometimes discrete and benignant, sometimes confluent and serious—at times normal, at other times abnormal. But in all cases the disease preserves its property of infecting healthy individuals by miasmatic contagion (infection) ; and its virus, even when taken from an almost absolutely local eruption, never gives more, in bovine animals, than the papular eruption which ordinary human Variola produces in these creatures.

The Academy of Sciences commissioners conclude their verdict as follows :—“ The experiments, the results of which have been just mentioned—experiments as remarkable by their number as by their distinctness (*netteté*) and concordance—appear, therefore, proper to solve the debatable points in view of which they were instituted. In establishing that Vaccinia and Variola, notwithstanding the features which assimilate them in animals as in man, are, nevertheless, totally independent of each other ; that their

viruses form two distinct individualities ; that the two affections thus constitute two different, immutable species, which cannot be transformed one into the other ; that, consequently, to seek to produce *Vaccinia* from *Variola* would be to pursue a dangerous chimera, which would revive all the dangers of inoculation of by-gone days—in establishing facts of such great importance, the experiments directed by M. Chauveau have rendered an incontestable service to science and to medical practice.”

Such was the opinion expressed by the representatives of the Academy of Sciences with regard to the Lyons experiments, and after reading the account of them, and knowing well the very trustworthy character and great professional ability of M. Chauveau, I think no doubt whatever can be entertained as to the justness of that opinion. And, besides, it must be remembered that an Italian medical commission, which carried on similar experiments and investigations at Turin, from 1871 to 1874, came to the same conclusion that Chauveau did—that human Small-pox cannot be converted into Cow-pox when the virus is transferred to bovines, but always preserves its original character.

The advantages and opportunities the Lyons commission could avail themselves of were very great. The magnificent veterinary school of that city was placed at their disposal, with as many horses as they required for experiment, as well as lodging and food for the other numerous animals they employed in their investigations. The 160 cows and bulls, and 40 pigs, at the Imperial Agricultural School of Saulsaie, were at their service ; as well as about 100 cows and numerous sheep and goats at a large farm near Lyons. For experiments on the human species, the *service des vaccinations* at the Hôpital de la Charité, presided over by Drs. Berne and Delore, as well as a member of the commission—M. Horand—was made available. The experiments were conducted with the greatest care and deliberation, and were very numerous ; the observations on them were drawn up by Dr. Horand. They were divided into two orders or sets ; one order of experiments with vaccine virus, another with that of human Small-pox. Each of these again was arranged in series, and each experiment in the series is described in detail in the report.

The *Variola* experiments are those which have most interest and importance for us, so far as the identity of Small-pox and vaccination are concerned ; though those with *Vaccinia* have a more or less direct bearing on these, as well as on animal vaccination. More especially is it necessary to refer to the results of the first group, in order to refute the statement made at the London conference, that the Small-pox matter was merely deposited in a little pouch in the cow's skin, and then re-transferred to the human subject, to whom it gave Small-pox. Quite cognisant of what had already been achieved in this direction, the greatest circumspection was observed in guarding against fallacious conclusions ; and the perfect knowledge possessed by Chauveau of the nature and habits of animals, their structure and diseases, as well as of experimental methods, was certainly an advantage of which few, if any, previous investigators could boast

In order to study Variola inoculated on the bovine species, twelve animals were selected which were known not to have had Cow-pox. Of these, nine were cow or bull-calves, two were recently-calved milch cows, and one a six-year-old pregnant cow. They were all inoculated with Small-pox matter, between December and April, the material being obtained from four people affected with Small-pox, and who had never been vaccinated; it was always employed very fresh. The inoculations were made at the vulva in the females, and perineum and scrotum in the males, and exactly in the same way as in vaccinating—the punctures being sometimes sub-epidermic, at other times quite subcutaneous. In none of the animals were there observed the slightest general phenomena—no disseminated eruption, fever, loss of appetite, or diminution of the lacteal secretion. With regard to the local phenomena, they were so trifling that in a first series of experiments they were inappreciable; hence the error of some of the preceding experimenters, who concluded that cattle could not be successfully inoculated with Small-pox virus. But other experiments proved this to be a fallacy; and a drawing accompanying the report shows the perineal region of a bull-calf, on the left side of which five sub-epidermic variolous inoculations had been made, and the effect of which had arrived at its *sumnum* of development. There were small, red, slightly-prominent papules, from two to four millimetres in diameter, and slightly conical, in the centre of which the inoculation-puncture could be distinguished. These papules commenced to develop on the second day, and on the fifth had arrived at the dimensions shown in the drawing. On the twelfth day they had completely disappeared, after furnishing at the seat of puncture, an extremely small, darkish crust. This course was not observed, however, in all the twelve inoculated animals; but it was remarked that the deep punctures did not furnish more evident results than the sub-epidermic ones. The former, though made with a cannulated needle highly charged with virus, only gave rise, indeed, to an eruption in which the papules were not so red or circumscribed as in the latter, and frequently could only be distinguished in the skin by passing the finger over them. Some deep inoculations were made by passing the virus through a wound several millimetres in extent, made by a lancet. The results were no more marked.

The apparent absence of a specific character in the papular eruption produced by inoculating the Small-pox virus, might have led to the belief that it was merely inflammation produced at the seat of puncture. For instance, the first animal inoculated was a calf, which was inoculated at the vulva. A number of small papules appeared, and it was imagined that a very characteristic eruption of Cow-pox was about to be developed; but instead of developing into pustules, they rapidly disappeared without leaving any trace of their existence, and then the result was considered negative, and the animal put to one side. But being desirous, some time afterwards, of producing Cow-pox by means of vaccine lymph of Neapolitan origin, this calf, being at hand, was vaccinated from a magnificent pustule raised on another calf which presented a very fine vaccinal eruption. On the eighth day the inoculation had quite failed, greatly to the astonishment and regret of the

Commission, as, relying on its success, they had not provided themselves with any more lymph, and had to send for another supply. Thinking the inoculation had not been properly performed, when the new lymph came it was tried again with the utmost care, but another failure resulted in this calf, while with other two animals—a horse and a calf—vaccinated at the same time, there was a beautiful eruption. The Commission were now compelled to admit either that the Small-pox inoculation had produced a specific eruption capable of protecting the animal from Vaccinia, that it had been previously affected with that disease, or that it had no receptivity for the vaccine virus. At that time only about eight bovines had been vaccinated, and it was not certain whether this species would contract the Cow-pox in this way. The experiments were continued, altogether ten animals were variolised, and then vaccinated some days afterwards ; but six had no vaccinal eruption whatever, three had rudimentary and ephemeral pustules, and one only showed a regular and characteristic Cow-pox. Considering the readiness, as was afterwards found, with which true Cow-pox, human Vaccinia, and Horse-pox could be inoculated, and that the former could only be produced very exceptionally when the animals had been previously variolised, the conclusion arrived at by this important chance discovery was that variolisation exercises a neutralising influence on the development of Vaccinia ; and that the slightly-marked eruption, so undecided in character, caused by the inoculation of Small-pox virus on bovines, is of a specific nature—in this species presenting, with the Cow-pox, the same relations that Variola and Vaccinia do to each other in the human species.

It is curious to note that, in 1863, the same (Lyons) Commission was desirous of discovering whether Small-pox could be transmitted to animals, and they made a number of inoculations, but all these apparently failed. Subsequently the animals were inoculated with human vaccine, and the same negative result followed. But it was never suspected then that the vaccination failures were due to the previous variolation, supposed to be ineffective, and it was concluded either that human vaccine takes with difficulty on the bovine species, or the animals experimented upon had previously been affected with Cow-pox. It would thus appear to be demonstrated in the clearest manner that Variola and Vaccinia are related, or rather opposed, to each other in the bovine species, in the same way as they are in mankind. The negative results following variolation in animals which had been successfully vaccinated, was a crucial test of the soundness of this demonstration. Three animals—a cow and two calves—were variolised and vaccinated at the same time, the Small-pox matter being inoculated on the left side of the vulva, the vaccine lymph on the right. In the three there appeared on the right side the very characteristic vaccinal eruption, and on the left the typical papular eruption engendered by variolation, as in two of Ceely's experiments.

To prove whether, after all, the papular eruption produced by Small-pox virus might not be a mild kind of Cow-pox, the feeble eruption of which could, by a methodical cultivation on bovines, become more developed, its transmission was attempted to other cows ; for the eruption differed from

human Small-pox in being always local, while the papules, neither in volume, external characters, nor development, bore the slightest resemblance to that disease; whereas by its localisation, development, and the absence of general phenomena, it did somewhat resemble Cow-pox, though in other respects it widely differed. Three calves inoculated from the fully-developed eruption with all the care possible, showed still less local alteration, while with a young bull it entirely failed, and subsequent vaccination was most successful. From this it was concluded that the variolic virus, instead of being cultivable in the ox tribe, loses its activity, and scarcely produces any effect in the second generation.

Was this eruption, then, merely that of modified Small-pox? The results of Small-pox inoculation on man are nearly as well known as natural Small-pox itself, and there could be no mistake in the result if this bovine eruption was successfully re-transmitted to the human species. With the object of proving this, an unvaccinated infant, three months old, was inoculated with a very small quantity of serosity obtained by scraping some of the papules on a variolised cow. Four days afterwards on one of the punctures a pimple was noticed, which soon assumed all the characters of a vaccinal pustule, and in nine days it was large, umbilicated, surrounded by a red areola; very irregular at its periphery, and covered on its surface with a kind of small vesicle; it was *aquarellée*. When opened, only a very small quantity of fluid could be obtained from it to inoculate the arm of another child. Next day the infant was feverish and ill, and on examining it carefully a great number of small pimples were found on the face and trunk; on the following day these were fine variolic pustules, the majority of which were umbilicated, and formed a quasi-confluent eruption. In a week the pustules were desicating and the child recovering.

The child inoculated from this one had three punctures on each arm, all of which had a *bouton*; in eight days from inoculation the development of these was complete, and they so closely resembled vaccine pustules that several competent persons asserted they were such. The next day two small vesicles appeared around each pustule, and in four days some Small-pox pustules (about fifteen) showed themselves on the face and other parts of the body. The child did not appear to be unwell, and the slight general eruption disappeared rapidly without leaving any traces.

Thus, in a second generation in the human species the variolic virus from the cow had produced much better local effects than in the first, and incomparably feebler general effects. What might it have been in a third or a fourth generation? The fear of creating an outbreak of Small-pox in the hospital brought these transmissions to a conclusion. But even the very decided results obtained did not suffice to satisfy the Commission. After all, the eruption on the children, though it appeared to be due to nothing more than direct inoculation of human Small-pox, might be only generalised Vaccinia, which some authorities assert does occur. But such a confusion between the two diseases was proved by the foregoing experiments to be impossible. Deposit humanised vaccine beneath the skin of a calf, and an

eruption of unmistakable vaccinal pustules is obtained, which can be indefinitely transmitted to animals of the same species. But inoculate with Small-pox virus, and there is only an insignificant papular eruption, the transmission of which from one calf to another is extremely difficult, if not impossible.

To meet any objections, however, that might afterwards be raised in this respect, two calves—a male and a female—were inoculated with virus from the last-mentioned child. In seven days, in both animals, there was a somewhat microscopic papule at the seat of puncture. One of these papules—on the scrotum of the male—was used for the inoculation of another calf, but the result was absolutely negative; proving, in the first place, that the virus transferred from Small-pox infected man to bovines, and carried back to man again, is still Small-pox virus, and is not converted into Cow-pox virus; and in the second place, that Small-pox is not Vaccinia.

Some experimenters had previously attempted to inoculate the horse with human Small-pox, but met with only negative results. The Lyons Commission undertook several series of experiments on this animal, somewhat similar to those on bovines, and arrived at analogous conclusions. The horse was as susceptible of inoculation as the ox tribe, and the same phenomena were produced; but the papular eruption developed at the punctures was so evident, that no doubt whatever could exist as to its presence and its specific character. Indeed, it was so greatly developed that inexperienced observers might have mistaken it for Horse-pox, particularly at the commencement. But in Horse-pox, as in Cow-pox, and even more so in the former, there is a secretion and the formation of a crust; but these are nearly, if not quite, absent in the inoculated Variola. The same experiments were made in vaccinating after inoculation, and *vice versâ*, as with the ox, with exactly the same results. The horse was also proved to be as little adapted to the cultivation of Small-pox virus as bovines. Three children were inoculated from the horses, and though the phenomena observed are of considerable interest, yet I cannot allude to them in this place, but will merely remark that the patients offered symptoms, mild in their degree, similar to those which follow Small-pox inoculation. The result arrived at was that, as with the ox, the horse returns the Small-pox virus to man just as it receives it. But the production of Variola in the three children was followed by a mild attack of natural Small-pox in an unvaccinated infant in the same room; and its mother, who had been vaccinated as a child, was soon after affected with a true varioloid eruption, with fever and other signs of general derangement.

The variolic virus obtained from the equine species was cultivated in mankind to the fourth generation, and produced a local and somewhat modified general eruption. From the second generation horses were inoculated, and only the typical variolic exanthem was developed—never the unmistakable Horse-pox. Transferred from the horse again to the ox, in order to be assured that the eruption engendered by the cultivation in man of the Small-pox virus, transferred originally from him to the horse, was not that of Vaccinia,

another series of experiments on cattle was instituted. Many horses were inoculated, and the conclusion arrived at was, that when carried to and cultivated on the cow, after producing in mankind, for several generations, local eruptions altogether identical in appearance to Vaccinia, the variolic virus of the horse only develops the phenomena of Variola, as in the bovine species.

Thus it will be seen how earnestly and exhaustively the Lyons Commissioners accomplished their task, and what conclusive results were arrived at. We can find no evidence anywhere in their report that the Small-pox virus was merely deposited in a little pouch, and re-inoculated from it again. On the contrary, marked phenomena were developed in every instance, and the crucial manner in which one series of experiments was made to test or control the results arrived at in another, left no room for doubt or error. Many of the experiments were original, particularly those on the horse, of which there were nine series.

The Commissioners, in closing their report, refer to the positive experiments of Thiele and Ceely as opposed to their negative ones—experiments which, they say, were extremely important, and which, notwithstanding the erroneous conclusions of their authors, will always hold a considerable position in science. Thiele and Ceely, they add, each experimenting independently, succeeded in giving Cow-pox to cattle by inoculating them with human Variola, and this Cow-pox became the origin of an excellent vaccine, which was cultivated in infants for more than twenty years, in certain parts of England, Germany, and Russia, and has passed through a great number of generations. It is not denied that they succeeded in obtaining positive results from their attempts to inoculate the cow with Variola ; but that which is astonishing, after the results arrived at by the Commission, is not these positive facts, but the negative results which other experimenters almost unanimously acknowledge. But had Thiele and Ceely well observed and closely interpreted the facts the manifestation of which they elicited ? Is it really true that they succeeded in converting Variola into Vaccinia ? The Commissioners think not, and are of opinion that the children they inoculated with their variolic vaccine had nothing else than Small-pox, the same as the children in the Hôpital de la Charité. This kind of inoculation is now-a-days well known, and it is really not necessary to have recourse to a new inquiry to appreciate its signification with regard to the doctrine of identity of Variola and Vaccinia. What did Thiele and Ceely communicate to the cow ? Was it Cow-pox ? It was nothing of the kind. The excellent drawings made by the Commissioners, representing the characters of the eruption produced in the ox by variolation, are evidence that there is not a very distant analogy between Cow-pox and the results of Small-pox inoculation. The Commissioners had not seen Ceely's drawings, consequently they did not know if they differed from those it produced ; but they ventured to assert that if they differed from these, and represented eruptions of veritable Small-pox, the artist had not been absolutely inspired by the real truth. Nothing that Thiele and Ceely had done in inoculating the cow with Variola could have produced anything resembling

Cow-pox, not even the extensive variolous wounds that were obtained, by making long and deep incisions in the skin, and pouring large quantities of Small-pox virus therein. But if their cows did not have Cow-pox, how were these two experimenters able to vaccinate children with the matter from them? The cows could not give that which they had not, say the Commissioners ; and this is why, they affirm, the children operated on by Thiele and Ceely received Small-pox ; and it was nothing but Small-pox which was developed on all their inoculated subjects. It was Variola such as the Commissioners had seen in their own experiments—Variola limited sometimes to the local primary eruption, and quite like Vaccinia ; Variola often accompanied by a secondary eruption, which gave it its special physiognomy. Between the descriptions of the two experimenters, and those given by the Commissioners, as to the eruptions which offered benignant characters, there was not the slightest difference ; and if the children inoculated by the latter were affected with Variola in consequence, so should those of Thiele and Ceely. If the virus of the latter is really vaccine, then it should give Cow-pox to the cow at once, like the Jennerian vaccine ; if not, then it will only produce the papules of the variolic eruption.

With regard to the pretended innocuousness of Thiele and Ceely's so-called vaccination, reported to be as absolutely harmless as true vaccination, the Commissioners did not believe that it was due to the passage of variolic virus through the bovine species, as it was found that it underwent a considerable attenuation in the organism of the ox, and could only be propagated through a very limited number of generations ; but when returned to the human species, it appeared to regain all its activity. When first transmitted to man from the ox or horse it caused a very abundant, nearly serious, secondary eruption, while all the children inoculated from this transferred virus had a discrete and almost insignificant eruption. The Commissioners clung to the opinion that Thiele and Ceely only practised variolation, instead of vaccination ; and these therefore gave the children they inoculated better protection than if they had been vaccinated, if they did not expose them to more dangers. A question of much interest is that of the innocuousness of mediate variolation, and if it be proved to exist, the Commissioners thought recourse should at once be had to Thiele and Ceely's method when good vaccine lymph could not be procured. But there is the grave danger of *contagion* ; for in passing through the organism of animals the Small-pox virus loses none of its infectious properties. Experience has only too well proved this ; and this is why mediate variolation, like direct variolic inoculation, would create, if it became generalised, permanent centres of infection, which would soon cover nearly the whole globe. This danger does not exist with the vaccine virus ; and therefore it is, that vaccination will always hold the first place in the prophylaxy of Small-pox.

I think I have now offered sufficient evidence of a clinical and experimental kind to prove that the Variola of man is not that of the cow, and that by no possible means can the virus of the one be transmuted into that of the other. The bovine organism cannot reduce a general eruptive disease, due to an ex-

ceedingly infectious virus, to a merely contagious and very mild disorder, accompanied by a limited local eruption. No more can the organism of the sheep; for the many experiments which have been performed with the Small-pox virus have not modified it in any respect, and it has retained all its original infective properties. Neither can the human organism transform *Vaccinia* into *Variola*, for had this been possible, surely the millions of vaccinations which have been made under every condition during this century, would have afforded us some evidence of such capability! If *Vaccinia* cannot be transformed into *Variola*, as little probability is there that *Variola* can be changed into *Vaccinia*.

Years ago the veterinary professor, Hering, had repeatedly inoculated the cow with vaccine lymph, and found that this gave it renewed potency. The veterinarian Numann made similar observations, and incidentally noticed that the bull is as susceptible as the cow; also that the horse and ass are, but that their vaccine, when re-transferred to man, is slower in its action than that from the cow. Besides, the transmission of *Vaccinia* by inoculation from cow to cow is accomplished without any difficulty, and the successive transplantations of the same lymph does not appear to have any influence on the development of the resulting pustules. In the very numerous experiments of Depaul, it was found that the pustules of the last inoculated animal offered the same characters and dimensions as those of the cow first inoculated. How is it, then, that the vaccine virus can be transmitted for generations from cow to cow, cow to horse, or horse to horse, retaining all its primitive potency, and even becoming revived when carried from the human species; whereas the virus of human *Variola* only produces a local papulation in them, quite unlike *Vaccinia*, which can rarely be reproduced more than two or three times, and which always develops Small-pox when inoculated again on man?

From all the evidence I have adduced, there is every reason to think that those experimenters who imagined they had produced *Vaccinia* by inoculating the cow with variolous matter, were in error; and if it be true that they employed the virus from the cow in vaccination, then if the above evidence be accepted as trustworthy, there is reason to believe that it was merely the Small-pox virus returned again to the human species, just as it was obtained from it. There are instances on record in which the most serious results have followed the attempts of imitators of Gassner, Thiele, Ceely, and Badcock—outbreaks of Small-pox resulting. Have the widespread epidemics of Small-pox in recent times been to any extent due to these inoculations of the cow with human *Variola*, with the view of obtaining vaccine lymph?

However these questions may be answered, one thing must be looked upon as definitely settled, and that is, that Small-pox is not Cow-pox; they are independent and distinct members of a family group, and can no more be transmuted or converted into each other than can two dissimilar plants or animals. The error in supposing that they are transmutable—or rather, that Small-pox can be converted into *Vaccinia*—was due, in all probability, to inacquaintance with experimental methods, an inability to appreciate the results of experiments, and imperfect knowledge of animals and animal disorders. No

control experiments were resorted to, as with those of the Lyons and Turin Commissions, and what may have looked *like* Vaccinia was accepted as Vaccinia. In no other way can I account for what must now be considered a grave error.

In insisting upon the correctness of this view, and urging its importance not only with regard to comparative pathology, but also the prevention of an odious and destructive human plague, I am well aware that I am placing myself in an attitude of antagonism to very high and estimable medical authorities in this country; and especially Sir Thomas Watson, who, in a paper in the *Nineteenth Century* (which paper has been recently republished in a small volume), says, "The truth is, that the vaccine disease is really Small-pox rendered mild by passing through the system of the cow; the great object of inoculating the Small-pox was to produce a benignant form of the disease by diminishing the number of its pustules."

I have shown that there is no relationship between the prevalence of Cow-pox and Small-pox, and that the one may, and does, prevail in localities, and at times when and where the other is not seen. In Denmark, for example, Small-pox is all but extinct, and yet cases of Cow-pox are far from rare. The difficulty experienced by those who believe in the unity of the two diseases, in accounting for this circumstance, is attempted to be got over in various ways. Bollinger, for instance (*Samnburg. Klinischer Vortrag*, No. 116), thinks that Cow-pox owes its existence sometimes to humanised vaccine—the most extended and extensive of all the forms of variolic contagium, he says. "We must look," he writes, "to humanised vaccine as the source from which the greater number of cases of bovine Variola have their origin." A few instances are certainly recorded in which, apparently, accidental infection of cows by recently-vaccinated people has occurred. Osiander alludes to the case of a cow which was so infected by a boy who had been vaccinated a short time previously. In the Prussian veterinary reports on contagious diseases among animals for 1870-71, Koch reports that the vaccination of the people on a farm occasioned the infection of the cows with Cow-pox, and in the same reports for the following year an outbreak of Vaccinia was announced as having taken place among a lot of cows, consequent on the re-vaccination of three dairymaids. In three weeks the disease appeared, and gradually extended, so that in fourteen days, of twenty-six cows, only three escaped. The majority of the cows had only a few pustules upon the teats, but others had a number upon the teats and udder. In the same reports for 1874-75, Damman describes an outbreak of Vaccinia in several sheds in the Rugen Kries, while in the district many children had been vaccinated, and the vaccine vesicles were fully developed. Schneider informed Bollinger that in 1876, after several children in a certain locality had been vaccinated, four cows in two sheds in the same place became affected with Cow-pox; two dairymaids became accidentally inoculated from these, and one of the women communicated the infection to her children, who had not been vaccinated. Reiter also told Bollinger that in cowsheds where he vaccinated cows, several non-vaccinated animals showed the

characteristic indications of the disease, which ran its course in the ordinary manner.

Though there is no reason to believe that Cow-pox is infectious—*i.e.*, virus *volatile*—yet there is as little reason to deny that cows may not become affected through contact with newly-vaccinated persons, provided that some vaccine lymph obtains access to a sore. But it is evident that this chance inoculation will not account for many, if any, of the reported cases of Cow-pox.

I have alluded to the experiments carried on in Italy from 1871 to 1874, with a view to decide the question as to the value of animal and humanised vaccine. On referring to the report,* I find the Commission was composed of a President and five members of the medical profession, one of whom was Professor Bassi, a very distinguished teacher in the Turin Royal Veterinary School, and a Secretary. Permission was given to make use of the cattle on the Royal farm at Turin; and the children in the Foundling Hospital, as well as the soldiers of the garrison, were made available in these experiments. Sixty-one cattle—chiefly cow-calves and heifers—were utilized, and the inoculations were made by puncture and incision, chiefly on the udder, seldom on the labia of the vagina. One side was, in most cases, inoculated with animal, the other with humanised lymph. This lymph was either that of natural Cow-pox, artificial Cow-pox (transmitted from cow to cow), humanised vaccine transferred to the cow; lymph transferred from arm to arm; or that of Horse-pox, from a natural outbreak of the disease in horses.

It is very important to note that two experiments were made to test the transmissibility of human Syphilis to calves. At the seat of inoculation there was formation of pustules, induration of the udder and the lymphatic glands, which continued for about a month; but otherwise the animals remained in good health.

The conclusions arrived at by the Commission were as follows:—

1. The results of inoculation by puncture and incision are the same, though in the thicker skin of adult man or bovines incision is preferable; for children puncture is not so painful, and takes less time. Incision alarms the mother, as it causes a little bleeding.
2. The time of year has no marked influence on the success of vaccination or re-vaccination, though temperature will hasten or retard the appearance of the eruption.
3. The form of pustulation is in man and animals essentially the same, except that in cattle there is less lymph, and the umbilicated appearance of the pustule is not so distinct.
4. The lymph from different sources has not the same potency. In Horse-pox, 72·9 per cent. of the inoculations were successful; in natural Cow-pox 72·8; and in artificial Cow-pox, 44·19.
5. Humanised lymph has double the potency of that from animals.
6. Humanised lymph conveyed to cattle diminishes in activity.
7. Natural Cow-pox lymph inoculated on mankind increases in potency.

* *Esperienze Comparative sul Vaccino Animale e sull'Umanizzato. Relazione della Commissione, etc. Torino, 1874.*

8. Comparison of the primary lymph with that of re-vaccination is greatly in favour of the former.

9. *Human Small-pox cannot be transmitted to cattle.*

10. The syphilis virus can be implanted in bovines, and successfully re-transferred to man.

11. Humanised lymph possesses more tenacity of activity than any other ; with properly preserved crusts or dry lymph, animals can be inoculated successfully.

12. Lymph is more easily procured from man than from animals.

13. The microscope gives no indication of the activity of lymph.

From what I have now stated, I think there are few who will continue to maintain that human Variola and Cow-pox are one and the same disease—*i.e.*, Cow-pox being merely Small-pox transferred to the cow ; or that there is any relationship or resemblance between them, except in so far that they are eruptive, run a certain course, generally attack the organism only once in a lifetime, and are antagonistic to each other. It would be strange, indeed, if the virus of Small-pox could be so changed that, by being passed only once through the system of the cow, it should completely lose its identity and never regain it, no matter how long it might afterwards be cultivated in its native soil ; and that, while before it could only be successfully transferred with the utmost difficulty to bovine animals, and perished in two or three removes, it should be capable, after its transmutation, of not only preserving its new characters of peculiar localised eruption and non-infectiousness, but also retain all its potency after endless transmissions through human, bovine, equine, and perhaps other animal species. “The poor unfortunate cow” is certainly not the victim of human Variola, as was asserted with more sentiment than accuracy at the conference, by a speaker who, nevertheless, confessed he had not succeeded in his attempts to produce Vaccinia from Small-pox.

Taking up this position, and supporting it by ample evidence, the knowledge we possess of virulent diseases in general, as well as the fact that the most extensive, careful, and exhaustive experiments by the ablest pathologists have failed in transmuting Variola into Vaccinia,* I may be asked how we are to

* Mr. Ceely himself affords us almost conclusive evidence as to non-identity between human Variola and Vaccinia, in the extreme difficulty, according to his own showing, with which the former could be transferred to bovines, and the remarkable facility with which the latter was propagated by the milkers. He says that in December, 1838, on a large dairy-farm where there were three milking sheds, Vaccinia first appeared in the home or lower shed. The cows in this shed being troublesome, the milker, from the upper shed, *after milking his own cows*, came to assist in this for several days, morning and evening, when in about a week some of his own cows began to exhibit the disease. It appears that, having chapped hands, he neglected washing them for three or four days at a time, and thus seemed to convey the disease from one shed to another. During the progress of the disease through this shed, one of the affected cows, which had been assailed by its fellows, was removed to the middle shed, where all the animals were perfectly well. This cow, being in an advanced stage of the disease, and of course difficult to milk, was milked first in order by the juvenile milker, for three or four days only, when, becoming unmanageable by him, its former milker was called in to attend exclusively to it. In less than a week all the animals in this shed showed symptoms of the disease, though in a much milder degree than it had appeared in the other sheds, fewer manipulations having been performed by an infected hand.

account for the success of two or three persons in this direction many years ago. We may, if we choose, refer to the Lyons commissioners' experiments and explanation for a reply, and conclude that the Small-pox transferred to the cow remained Small-pox still, though it was so modified in virulency, when re-transferred to man, as to produce at first only a local eruption, though in some instances Small-pox in a mild form followed. If I mistake not, more than one instance is on record, in which medical men have imitated Ceely and Badcock, and re-inoculating children from the cow, have produced nothing but Small-pox. Among other instances of this kind, I may refer to that of Martin (*Boston Medical Journal*, 1860). That practitioner inoculated the udder of a cow with Small-pox matter, and thought he had produced Cow-pox. Collecting what he believed to be vaccine lymph from the vesicles, he vaccinated about fifty children with it, but produced only a serious outbreak of Small-pox, from which several died.* And a similar, but more alarming occurrence took place in India. Even in one of Ceeley's reported successful cases of Vaccinia produced by variolation, we are informed that his assistant, in opening the supposed vaccine vesicle due to the Small-pox virus, accidentally punctured his hand with the lancet, charged with moist lymph. On the fourth day there was a hard, deep-red, papular elevation at the seat of puncture. This was followed by constitutional disturbance—as "headache and other febrile symptoms, with roseola and fiery red papulæ on the face and other parts." On the sixth day the constitutional symptoms were more intense, and the papulæ on the face, neck, trunk, and limbs exhibited ash-coloured summits, and appeared to have slight central depressions. Some of the papulæ presented light straw-coloured summits on the seventh day, and the febrile symptoms were abated; on the eighth day the papulæ were more yellow, and some were desiccating, but headache was still present.

But if it is admitted that it was really Cow-pox Ceely and Badcock contrived to transfer to children, might it not be suggested that in all probability the animals from which they transferred it were accidentally infected with the natural malady at the time they were inoculated with the Small-pox virus?

Cow-pox was far from rare in those days, and many might be inclined conclude, that if the animals supposed to have developed Vaccinia to from Small-pox were not inoculated with Small-pox lymph by mistake, they were already infected with Cow-pox, from which children were subsequently vaccinated. Ceely himself admits (*Transactions of the*

* Dr. Varian, writing in the *Philadelphia Reporter*, says:—"In 1864, being disgusted with the weak protective power of the humanised virus furnished by the Government, I determined to raise my own Vaccinia by inoculating cows with Small-pox virus. I made a number of experiments on adult animals, and finally on calves. Although every precaution was taken, I never succeeded in obtaining any result whatever other than an irritated sore. The animals all appeared to be totally incapable of being affected by the Small-pox poison. In the fall of the same year, Dr. Chase, in charge of the hospital at Jeffersonville, Ind., sent to me for a supply of Small-pox virus, in order to make the same experiment. I learned from his messenger, some months later, that Dr. Chase had also signally failed. Considering that we had thus subjected the matter to the *experimentum crucis*, I have no longer any belief in the identity of the two diseases."

Provincial Medical and Surgical Association, vol. viii., p. 378), that Cow-pox was prevalent in the locality when his experiments were undertaken, and he also states that in the only two instances in which he succeeded in producing Vaccinia by variolation, *the animals were also vaccinated quite close to the inoculation punctures*; while with a third heifer experimented on at the same time, *but which was not vaccinated*, there was no result.

It is somewhat extraordinary that, considering the grave issues at stake, Mr. Ceely has not been prevailed upon to undertake further experiments, and to repeat that success which could not be achieved by any subsequent experimenters, though they had the advantage of far more abundant means and facilities. Surely if, as has been asserted, Cow-pox could be so easily produced accidentally, by contact with Small-pox-infected people at the commencement of this century (though there is no proof of this), it should be as readily developed now, experimentally or accidentally; and especially when we find that vaccination—which some authorities say is only variolation—is easily and certainly practised in the bovine species. According to his own statement, Mr. Ceely only succeeded twice, under the conditions mentioned above, in producing Vaccinia from Small-pox, though his experiments appear to have been numerous. All subsequent attempts of most careful, skilled, and patient investigators have failed.*

But if the views I entertain are well-founded—and reasoning and facts are altogether in their favour—Vaccinia cannot be developed from human Variola; the two are distinct and special infections—as distinct as two individuals of different species. Vaccinia is as much a disease of the bovine species as Small-pox is a malady peculiar to man—each is a special form of Variola, and each exists and prevails not only independently, but marked with all its own particular characteristics and attributes. Both attack males and females, in direct proportion as these are exposed to contagion.

The symptoms of Small-pox in mankind are well known. Not those of Vaccinia, however, though Ceely has described what he designates the “natural disease” very clearly.† If we study the symptomatology in a large

* Before Ceely's attempts were published, as already mentioned, the question of identity between human and Cow-pox had been discussed by a number of authorities, and experiments had been instituted by several. This discussion appears to have commenced so early as 1802 (Wedekind, *Theoretisch-praktische Abhandlung von den Kuhpocken*. Basel, 1802), but both it and the experiments led to no results of a positive character. When, in 1839, Hering, Professor at the Stuttgart Veterinary School, published his excellent pamphlet (*Ueber Kuhpocken an Kühen*. Stuttgart, 1839) the question was summed up by him in the following terms: “Das Misslingen der bisherigen Versuche aus Variola Kuhpocken bei den Kühen zu erzielen, sollte indessen nicht abhalten, dieselben noch öfter, wo sich schlickliche Gelegenheit darbietet, zu wiederholen, denn nur eine sehr grosse Anzahl von Versuchen kann zu dem Schlusse berechnen, dass Menschenpocken auf Kühe übertragen, nie Kuhpocken hervorbringen.” Hering himself was opposed to the view that Cow-pox could be produced from human Small-pox.

† It must be remembered that at that time very little was known of animal diseases, or of the history of those wide-spreading destructive epizooties which have only been carefully studied within the last few years. We need not be surprised, therefore, to find grave mistakes committed with regard to bovine diseases, up to quite recent times, nor need we wonder at Mr. Ceely speaking of malignant Vaccine, and even Variola

number of cases artificially produced by inoculation with humanised vaccine lymph—no matter in what region of the ox the virus has been deposited, we shall find a remarkable constancy and regularity.

After the second or third day there is seen in a white-skinned animal at the seat of puncture, a small red papule which, on the third or fourth day, is somewhat large and prominent, rather pale, surrounded by a bright-red areola, and slightly depressed in the centre. From the fourth to the fifth day, the papule, now a vesicle, has a well-defined umbilicus, a marked areola, and an elevated margin. These characters are all the more developed towards the eighth or ninth day, when they begin to subside; the pustule becomes brownish-coloured in the centre, and yellowish or nacreous towards the margin. Desiccation has begun; the brown tint gradually invades the entire surface; the areola disappears; the prominence of the pustule is diminished; and towards the twelfth or fourteenth day nothing usually remains except the crust, which falls about the fifteenth to the twentieth day, leaving only a slight, but permanent cicatrix.

The same changes occur in a dark skin, but they cannot all be so readily perceived, in consequence of the pigmentation.

The size and prominence of the pustules may, of course, vary, and their base appear more inflamed in some cases than others, according to constitution, condition of the animal, and other circumstances: the evolution being generally most notable in those which are in good health. The virus seems to be most active towards the sixth or seventh day after inoculation, and then rapidly loses its potency. Indeed, it has been found that though there is then not so much lymph as afterwards, between the third and seventh days is the period when it is most potent.

As a rule, there is little or no general disturbance of health perceptible; and though in the natural disease a more or less generalised eruption has been observed in rare instances, yet it has not been noticed in the artificially induced malady; while it has not been at all unusual to discover a kind of secondary eruption, of exactly the same character, around the inoculation points—an eruption which might be due to accidental inoculation when the operation was performed. In the experiments of the Lyons Commission, a young bull, successfully inoculated in three places on the scrotum, on the sixth day had a newly-developed pustule behind one of the places. This had all the characters of the others, and though its presence was attributed to auto-inoculation, yet there was no certainty that it was so produced.

The natural Cow-pox I have described in my work on "Veterinary Sanitary Science and Police" (vol. ii., p. 91). The symptoms and course of the disease may be briefly described as follows:—After slight febrile disturbance,

appearing in cattle. In the same volume in which his observations appear, is a report on vaccination, drawn up by a medical committee; and the superstructure of the report is based upon the supposition that the Cattle-plague which had repeatedly visited this country, raged on the Continent, and was seen in India, was only Variola—*Variola vaccina*—which, transferred to mankind, conferred immunity from Small-pox! The same blunder was made in 1865 when Cattle-plague was destroying our herds, and vaccination was resorted to, to stay its ravages.

partial loss of appetite and suspension of rumination, trifling constipation and diminution of the urinary secretion—symptoms which may, nevertheless, be absent or unperceived—and lessened quantity, as well as altered quality of the milk (more aqueous and disposed to coagulate than usual), the udder is observed to be swollen, particularly near the teats, and is painful during milking. In two or three days there are seen on the udder, and chiefly on the teats, small hard tumours, varying in size from that of a pea to a haricot-bean, and of a pale-red hue. Increasing in volume, a viscid yellow fluid appears beneath the epidermis. At first this fluid is in the centre, but it soon extends towards the circumference, giving the nodosities or papules a light-blue tint in the middle, but a reddish-blue or yellow colour towards the periphery. At this period the centre is also usually umbilicated or depressed; the margin is hard, tumefied, and painful; and when the skin is thin and transparent, a red areola is noticed. These “pocks” gradually increase in dimensions, and towards the eighth or tenth day have acquired their maximum development. On the udder they are generally circular; on the teats they are oblong. The contents then become purulent in character, and a crust begins to form in the centre, gradually extending to the circumference. This crust is thick, shining, and deep-brown or black in colour; it is firmly fixed to the skin, from which it does not become detached until the tenth to the fifteenth day, unless accidentally removed. When it has fallen off, it leaves a cicatrix, which persists for a considerable time, and is at first bluish-red in colour, but gradually becomes pale. On the udder the cicatrix is depressed in the centre.

In the same animal there may be successive crops of papules and pustules; they may not all be developed simultaneously, some being crusted, while others are only nodes. The later eruptions may, however, be due to re-inoculation during milking; this is favoured by the existence of sores or fissures on the teats. In consequence of this circumstance, the malady may not pass through all its phases within a less period than a month or six weeks. The lymph taken towards the eighth or tenth day is most active for vaccination purposes.

The variable colour of the vaccinal pustules is not an essential characteristic of the disease, and does not therefore indicate the real nature of the eruption. If the skin is fine and white, the variolæ have a silvery-white, bluish-white, or slatey hue; if it is thin but dark-coloured, they are leaden-grey; if the hair is of a bright shade, they have a colour varying from a bright-red to a pale or blood-red tint, but always wear a metallic lustre. On a thick, white, and wrinkled skin they have a dull opaline lustre.

In exceptional cases, there is somewhat severe constitutional disturbance before the eruption appears. For instance, in the Wurtemberg Veterinary Reports for 1877, mention is made of a cow which showed a rather high degree of fever: hot skin, quickened respiration, horripilation, and rigors from time to time. On the four teats appeared more than a score of pocks; these contained a very small quantity of thick lymph, some of which was preserved in capillary tubes, and another portion removed by means of a fine hair-

pencil and kept in glycerine. These portions were successfully employed in vaccination. The owner of the cow was accidentally inoculated through milking the animal, a large pock forming on his hand.

In studying Cow-pox, it must not be forgotten that there is a spurious *Vaccinia*, sometimes designated *Vaccinella* or *Vaccinoïdes*: a disease, or several forms of disease resembling Cow-pox to some extent, but yet differing from it in several important features. It is generally observed soon after calving, and would seem to be contagious, as it attacks nearly all the cattle in a shed when one cow becomes affected. It appears to be very uncertain in its transimission to mankind, and to be also more or less enzoötic. The symptoms are much like those of Cow-pox, the only important differences being in the character of the exanthem, and the lesser degree of virulency of the infecting agent. The eruptions of spurious *Vaccinia* are divided into three groups. One consists of acuminate papules or pustules, which may or may not be developed at the same time as the true pock; they appear as small red nodes about the size of a grain of millet, destitute of areola and umbilicus, and soon changing into a conical pustule, the contents of which quickly desiccate, and form a crust—the whole process only occupying from four to six days. The eruption may appear several times, however, so that the entire period will extend over a number of weeks. The second group is composed of hard indolent tumours, the so-called *Steinpocken* of the German veterinarians; they vary in size from that of a pea to that of a nut, are somewhat red at first, and have no areola; or they may appear as a kind of warty excrescences on the skin of the udder. They frequently remain unaltered for weeks, or even months, and at last disappear very slowly. Emphysematous and watery vesicles constitute the third group. They first appear on the udder in the form of red spots, which are rapidly transformed into vesicles ranging in size from a pea to a cherry, but destitute of areola and umbilicus. They contain a serous or purulent fluid, are readily broken, and are covered by very thin crusts, which soon fall off. Frequently their contents are quickly absorbed, leaving only an empty epidermic envelope, which constitutes the emphysematous pock. They pass through all their phases within five or six days.

Such is Cow-pox, as we know it at the present day; and its course is exactly that of human vaccination with Jennerian vaccine, which is in reality nothing more or less than the Cow-pox transmitted through very many successive generations of mankind. The vesicle of *Vaccinia* has been simply transferred from the cow's udder or teat to the human arm—there is nothing whatever of Small-pox in it.

Hering's treatise on Cow-pox in the Cow (*Ueber Kuhpocken an Kühen*, Stuttgart, 1839) only came into my hands when the greater portion of this paper had been published. It is the most complete work on the subject I have met with, and the facts he has collected are entirely in favour of what was then designated the "spontaneous development" of the disease in the cow—*i.e.*, independently of Small-pox and Horse-pox. In this place, now, I can only give the results of his investigations, and the deductions he draws from

the materials collected during ten years' extensive and careful observation in Wurtemberg. In 283 outbreaks of the spontaneous or original disease (*originären Kuhpockenfallen*), in which more than 400 cattle were involved, people were successfully inoculated in sixty-nine of them ; in seventeen the disease was accidentally transmitted to people in milking diseased cows ; in 152 cases of apparently genuine Cow-pox, inoculation was either unsuccessful, incomplete in its results, or impracticable ; in forty-nine cases was the result irregular with regard to course, form, etc., while in eighteen cases experimental inoculation was without result. The number of successfully inoculated children (one case was that of a person twenty-two years old) was 427, and from these at least 550 more were vaccinated with good effect. Much of the lymph from these was distributed to the vaccination establishments. The summary of investigations was as follows :—

1. Original Cow-pox (*originäre Kuhpocken*) is frequent (*häufig*) in Wurtemberg ;
2. The geological condition of the country or locality has no influence in its production ;
3. Neither have elevation or climate (heat or cold) any influence ;
4. Neither have these any apparent influence on the form or course of the disease ;
5. Cow-pox is most prevalent among the cows of the smaller proprietors ;
6. Change of food, and especially from dry to green fodder, as well as transport and traffic in cows, appears to favour the development of Cow-pox.
7. The disease is no more frequent with under-bred than high-bred cows ;
8. Re-inoculation from man to the cow is very successful ;
9. Public notification and bestowing rewards, are beneficial in drawing the attention of cattle-owners to the existence of the malady ;
10. Original Cow-pox is prevalent all the year round, but is most frequent in May and June ;
11. Cases under two and over ten years of age are exceptional in cows—the majority of cases occur in animals three, five, and six years of age ;
12. Cows newly-calved are more susceptible to the disease than those which have been for some time in milk ; though cows which are not in milk, and those which have not calved, are not exempt ;
13. The usual symptoms of general disturbance (fever, distress, inappetence, etc.), are not unfrequently either wholly or partially absent in true Cow-pox ; but when present there is, as a rule, a diminution in the quantity or deterioration in the quality of the milk secreted ;
14. Genuine Cow-pox (*ächte Kuhpocken*) usually appears on the teats, and less frequently on the udder. The number, form, and size of the pocks vary. The areola and umbilicus are frequently absent, and often nothing more is at first noticed than a hard nodule. The dark-blue or livid colour is not characteristic—indeed, the whitish or yellowish, and silvery or pearly pock is even more frequent ;
15. The course of real Cow-pox is slow but definite, which is not the case

with the so-called false Cow-pox. The pustule is fully developed in from eight to ten days, and the thick brown crust remains for three to four weeks. The appearance of the pustules is very irregular, sometimes eight to fourteen days elapsing before new ones make their appearance. Their structure is cellular, and the contents at the beginning are transparent and more or less adhesive; later it is purulent and finally cheesy, and it is always odourless. Only in the earlier stage is the lymph most active. The cicatrix is apparent for twelve months;

16. It is not clearly ascertained whether Cow-pox may appear more than once in the same cow, even during an epizooty of the malady;

17. Infection from cow to cow is not common, the disease being generally spread through milking;

18. Cases of persons being infected through milking are seldom observed, and then the consequences are not serious;

19. The original lymph is more active when inoculated in children than humanised lymph, this being probably partly due to the fact of the former being more foreign than the latter, and partly to the brief time that elapses before the primary lymph is used. The lymph when dried, or in the form of crust, is much less active than when fluid;

20. The pustules produced by this lymph, when children are inoculated with it, are large and accompanied with severe local inflammation, high fever, and longer course than in ordinary vaccination. In a small number of cases only is the contrary observed. The greater activity of this lymph is often maintained to the second and third generation of inoculations. Such inoculations seldom fail.

Hering describes and gives coloured drawings of real Cow-pox (*Variola vacc. ver.*), Blue Cow-pox (*Variola vacc. cœrulea*, Nissen), Secondary Cow-pox (*Variola vacc. Secundaria*), Warty Cow-pox (*Variola vacc. verrucosa*, Viborg), Miliary Cow-pox (*Variola vacc. miliares*), Yellow or Bernstein Cow-pox (*Variola vacc. succinea*, Nissen), Black Cow-pox (*Variola vacc. nigra*, Nissen), Water Cow-pox (*Variola vacc. bullosa*.)

HORSE-POX.

I have casually and repeatedly alluded to Horse-pox, and it is necessary to again refer to it; as if what transpired at the Vaccination Conference is to be taken as evidence of our state of knowledge with regard to this kind of Variola, we would deserve to be accused of unpardonable ignorance. If for no other object also than to rescue the reputation of Jenner from the charge of error preferred against him in this matter, it would be more than worthy of our attention. It is well known that Jenner expressed himself as of opinion that Cow-pox was derived from horses affected with what was then, and is even now, properly termed "Grease." But for very many years, and also at the recent Conference, it has been denied that there was any relationship between the disease of the horse and Cow-pox; and on the latter occasion it is reported that one of the speakers, in remarking that "all who were acquainted with the subject were well aware that there were some erroneous

views originally held by Jenner with respect to the conveyance of that particular disease (Cow-pox) from one animal to another—from the horse to the cow, and that it was in consequence of that conveyance that the cow became affected with a disease that he called Cow-pox," added : "In the present day, perhaps, it was unnecessary for him to say that among veterinary surgeons who were acquainted with the lower animals, that opinion had always been negatived. He was of opinion that Jenner saw the disease of the animal, and that it was of a repetitive nature, which by his own observations he was well aware did not possess any particular quality." It is scarcely necessary to remark that intelligent students of veterinary medicine do not negative Jenner's opinion, but know for a well-established fact that he was justified in that opinion ; inasmuch as horses suffer from a malady closely resembling the so-called "Grease" (which is simply a kind of catarrhal inflammation of the sebaceous follicles of the skin at the lower part of the limbs), and that this malady is transmissible to the cow and to mankind, producing a train of symptoms so exactly like *Vaccinia* that no material difference can be discerned between the two maladies.

Jenner was too serious a philosopher and exact observer to make light assertions or superficial examinations, and he only erred when he stated that the one source of Cow-pox, and even of Small-pox, was to be found in the horse. He was absolutely correct as to a particular cutaneous disease of the horse's limbs being transferred, by means of human hands, to the cow's udder, and there producing Cow-pox, which again could be communicated to people and protect them from Small-pox. The facts, accidental and experimental, upon which he based his assertion are unmistakable and indisputable, and the "sore heels" or "Grease" he describes as affecting horses and infecting the farriers who shod, or the grooms who attended to them, was nothing more or less than "equine Variola" or "Horse-pox," a disease which appears to have been far more frequent then than now, probably owing to the insanitary condition in which horses were kept in those days. Reference to his work* will show that Jenner knew more of the variolous diseases of animals than many more recent authorities, and that this "sore heel" disorder, or "Grease," was eruptive in character, and could produce Cow-pox. Jenner's discovery—for discovery this really was—was confirmed by Dr. Loy, of Pickering, who, in a little pamphlet which appears to be now quite unknown,† is even much more explicit than Jenner with regard to the nature of this inoculable "Grease," and he resorted to direct experimentation to prove the relations between it and Cow-pox. His earlier experiments failed, in consequence of his not being able to distinguish between the ordinary and the specific malady. At last, he states, he had the good fortune to find a horse on whose heels the matter was much more limpid than in all the preceding ones—on the fourteenth day of the disease, the seventh of the

* "An Inquiry into the Causes and Effects of the Variolæ *Vaccinia*, a Disease discovered in some of the Western Counties of England, particularly Gloucestershire, and known by the name of Cow-pox." London, 1798.

† "Account of some Experiments on the Origin of the Cow-pox." 1802.

discharge from the heels. Four cows inoculated with this matter showed the usual symptoms of Cow-pox, and a child also inoculated with it on the arm on the third day had a papule surrounded by slight inflammation; on the fourth day the papule was very elevated, and on the fifth day there was a purple-tinted vesicle; on the sixth and seventh days the vesicle had increased and was darker. At the same time there was fever, headache, quickened respiration, frequent pulse, white tongue, etc., which symptoms declined towards the ninth day. On the sixteenth day after inoculation from the horse, the child was inoculated with Small-pox matter without result. Loy alludes also to a farrier and a butcher of Pickering, who, in applying dressings to the heels of a horse affected with "Grease," became inoculated. Desirous of ascertaining whether the pustules which were on the hands and forehead of the butcher could communicate the disease by inoculation, he inserted some of the matter from one of them into the arm of his brother, who had never had Small-pox. The result was exactly the same as inoculating with Cow-pox virus. Loy recognized two kinds of "Grease"—one merely local and non-infective, the other local and constitutional (eruptive), which gives the disease to those who groom or handle the affected horses. With the first kind there was no general disturbance, but with the second at the commencement the horses exhibited symptoms of fever, "from which they were relieved as soon as the disease appeared at the heels, and there was an eruption on the skin. The horse, the matter from which communicated the disease by inoculation, was very unwell until the appearance of sore heels, which was, as in all the other cases, accompanied by an eruption over the greater part of the body." The fact that inoculation from the "constitutional Grease" was a protection from Small-pox, and that the rather severe effects of direct transmission from the horse to the human species were modified by passing the virus through the cow, or through mankind, was fully recognized by this enlightened observer; as well as the other important fact, that the matter was only certainly effective when perfectly limpid, which was in an early stage of the disease. Loy likewise remarked that neither the original nor the communicated disease was infectious through the medium of the atmosphere.

The observations of this contemporary of the illustrious Jenner are extremely interesting, while they are decisive as to the intimate relationship existing between Horse-pox and Cow-pox. Though his pamphlet consists of only a few pages, it contains facts of great moment with regard to our subject, and there is perhaps nothing more astonishing in the whole range of medical literature, and especially that of vaccination, than the oblivion into which the record of his observations immediately fell. The opinion so strongly expressed by Jenner, based as it was on well-observed facts, and the convincing demonstrations (clinical and experimental) of Dr. Loy, do not appear to have availed much in establishing the existence of such a malady as Horse-pox. Very long ago a few experimenters, medical and veterinary (among the latter of whom was Coleman)—in order, I suppose, to test the correctness of Jenner's view—attempted to transmit the "sore heels" or

"Grease" to horses and cattle, but failed, as Woodville and Simmons (mentioned by Loy) had previously done, and for the same reason—they inoculated from the local non-constitutional malady, overlooking the distinction which had been so well drawn by the Pickering physician with regard to the simple cutaneous disorder and the specific eruptive one. Consequently, Jenner was set down as having made a mistake; the existence of Horse-pox was denied, and even at the recent Vaccination Conference the same speaker who asserted that veterinary surgeons had always negatived Jenner's opinion, said that Jenner saw the disease of the animal ("Grease"), "and that it was of a repetitive nature [*sic*], which, by his own observations, he was well aware, did not possess any particular quality. . . . With the exception of the sheep, he knew of no other animal that was affected with Variola. There was an equine Variola which was produced from the cow (?), but he had never seen Variola in the horse. He knew it had been stated of late that cases of that disease had occurred in France, but all he said was that our observations had been extensive and minute, and they had seen nothing approaching to it in a horse or dog, or any other animal except the sheep." Five years before these words were spoken, the Horse-pox had been carefully described in English veterinary literature, and the malady had not only been observed on the Continent, but in England and America, and its existence proved over and over again beyond a doubt.

Dr. Loy's pamphlet was translated into French by Dr. Carro, soon after its appearance in England, and published in the "Bibliothèque Britannique" in the year X. (vol. xxi.). Carro was a great admirer of Jenner, and he dwelt with much force on the clearness and precision of Loy's experiments, as furnishing indubitable proof of the justness of the opinion of the introducer of vaccination. But Carro, in his eulogistic comments on Loy's work, remarks that the French vaccinators had experienced great difficulty in understanding what the English term "grease" really meant, some thinking it was *javart* (fistula of the foot from injury), or *eaux aux jambes* (simple inflammation of the sebaceous follicles—*vulgo*, common "grease")—an uncertainty," adds Carro, "which shows what little care the English have observed in describing the *grease*, and is probably the cause of the small progress this interesting portion of the veterinary art has made among them." The French veterinarians and medical men who tried Loy's experiments had no better success than those in England who did not have recourse to the eruptive disease for inoculating material; consequently, in France, also, Jenner and Loy were believed to be in error, and nothing more was thought of Horse-pox or "constitutional Grease."

But it is curious, in the midst of this incredulity, to find Carro himself adducing most valuable confirmatory proof of the correctness of Jenner and Loy's statements, in a letter addressed to Professor Pictet, of Geneva, in 1803, and published also in the "Bibliothèque Britannique." In this letter Carro writes:—"Les maréchaux-ferrants de Salonique distinguent trois sortes de javart : l'*écrouelleux*, le *phlegmoneux*, le *variolique*. Ce dernier paraît être le même que le *grease* constitutionnel du docteur Loy, car il est

accompagné d'une éruption semblable à la petite vérole. Aussi, d'après le rapport des bergers Albanais, les vaches sont elles sujettes dans ce pays à une maladie qui paraît avoir une grande ressemblance avec le Cow-pox des Anglais; et ce que décide la question, c'est que le docteur Lafont, établi depuis longtemps à Salonique, en Macédoine, a réussi à produire la véritable vaccine sur deux enfants inoculés avec le virus pris sur les jambes d'un cheval atteint de cette troisième espèce de javart, quoiqu'il ne produisît aucun effet sur une vache soumise aussi à cette inoculation; et cette vaccine s'est propagée de ces enfants à d'autres par l'inoculation, avec ses caractères et sa bénignité ordinaires."

And evidence proving the existence of Horse-pox was cropping up now and again, though it was not readily accessible to the medical world of those days. For instance, in the spring of 1805, Viborg, professor at the Copenhagen Veterinary School, inoculated a cow with matter obtained from the heel of a horse affected with the specific form of so-called "Grease." On the fifth or sixth day on the udder and teats were bright transparent vesicles, with the characteristic areola and umbilicus of Cow-pock; and the cow exhibited a high degree of fever, while the secretion of milk was nearly suspended.* Sacco made similar experiments, and these and his observations are as valuable as Loy's, confirmatory, as they were, of the existence of Horse-pox, and its ready transmissibility to men and cows, producing an exanthem which could not be distinguished from Cow-pock.† In 1830, Professor Hertwig and eleven students of the Berlin Veterinary School, became inoculated through handling horses affected with the disease in the limbs, more particularly. This form of Grease—in reality Horse-pox—was then prevailing as an epizooty in North Germany.‡ In the same year Professor Ritter, of Kiel, found a man who had been accidentally inoculated in the hand with matter from horses' heels. The vesicle or pustule exactly resembled that of a Cow-pox, and from it he inoculated two children; the result was undoubted vaccine vesicles.§ In this year, also, Dr. Rosendahl, of Nostorf, had the opportunity of observing the transmission of Horse-pox to several men; there was accompanying fever, and in some cases delirium.|| Berndt alludes to an instance in which a boy was infected from a horse suffering from the so-called "epizootic Grease" (*epizootischer mauke*), and from the eruption on him people were inoculated most successfully, fine cow-pocks being developed.¶ And so on with other instances.

But in every country to which Jenner's views had penetrated, much uncertainty prevailed with regard to the nature of the disease termed "Grease" or "sore heels"; and therefore disappointment only too often followed

* "Vet. Selsk. Skrifter," vol. ii., p. 137.

† "Trattato di Vaccinazione, con osservazioni sul giavardo et Vajuolo pecorini," 1839.

‡ "Med. Zeitung von dem Verein in Preussen," 1834.

§ Pfaff's "Mittheilungen aus dem Gebiet der Medicin." Jahrgang ii. Kiel, 1833.

|| *Ibidem.* Altona, 1835.

¶ Rust's "Kritischer Repertorium," Band xxi.

attempts to transmit it to the cow, and so to produce Cow-pox.* In Italy, for instance, the term was translated into *giardone*, pedal fistula ; and the possibility of producing such a disease as Cow-pox from this condition placed the reputation of Jenner very much at the mercy of captious critics.

In 1840, Dard saw the disease among horses in France, and called it *Rhinite pemphigoïde* ; in 1843 it was again observed in that country by Bouley, now director of the French Veterinary Schools, who designated it *Herpes phlyctenoïde*, to distinguish it from Glanders and Farcy, which it somewhat resembles. But it was not until 1860 that the discovery of Jenner and the researches of Loy received further confirmation, and scientific attention was seriously directed to it. In the spring of that year the horses in the commune of Rieumes, not far from Toulouse, were attacked with a disease which assumed an epizootic form, and in less than three weeks more than a hundred were affected. M. Sarrans, the district veterinary surgeon, reported the disease as commencing with slight fever, soon followed by local symptoms, the chief of which were hot and painful swelling of the limbs, with an eruption of small pustules on the surface of the tumefied parts. In three to five days a purulent kind of discharge took place in the pastern, which continued for eight to ten days, during which the inflammatory phenomena gradually subsided ; then the pustules desiccated, and towards the fifteenth day the crusts began to fall off, carrying the tufts of hair with them, and leaving more or less perceptible cicatrices. The eruption appeared not only on the limbs, but on other parts of the body, particularly on the nostrils, lips, flanks, and vulva. There was no Cow-pox present in the locality, and the extension of the disease seemed to be due entirely to contagion. No fewer than eighty mares were infected from being sent to the Government stallions at Rieumes, the ropes with which their hind limbs were secured (passing round the pastern) being impregnated with the discharge from the heels of some diseased mare. Only three mares and two stallions escaped attack. One of the animals exposed to infection chanced to be sent to Toulouse, and not appearing so well as usual, it was left at the Government Veterinary School. It was not until it had been there for eight days that Professor Lafosse observed the mare to be dull, suffering from inappetence, and lameness in both hind limbs, with difficulty in flexing the fetlocks, and a hot, painful swelling, confined to the left fetlock, extending higher on the right leg. On these swollen parts small tufts of hair were erect here and there, and at those places there were what appeared to be pustules, from which exuded a fluid matter possessed of an ammoniacal odour, but less fetid than that of Stearrhœa ("Grease"). Lafosse thought at first that it was only the latter disease in an acute form ; and he was happily inspired to inoculate a cow, in order, once more, to submit the Jennerian doctrine to an experimental test. The experiment was made eight days after the manifestation of the eruption on the mare, and

* In the nomenclature of disease drawn up by a joint committee of the Royal College of Physicians, and published in 1869, I find "Grease" named *Equinia mitis*, and defined as "a pustular eruption produced by the contagion of matter from a horse affected with the Grease."

was perfectly successful. Papules, then pustules, formed on the cow wherever the matter obtained from the mare had been inserted with the lancet—large, flat, firm, and round pustules, with a central umbilicus, which caused the borders to appear raised—they were the vaccine vesicles, in fact. Another cow was inoculated from this one, and had a very fine Cow-pock, from which a child and a horse were vaccinated, and these had a magnificent vaccinal eruption. A second child, inoculated with the matter from this horse, had, in its turn, a well-developed pock. Comparative inoculations were then made on children and horses with the equine virus and the ordinary humanised vaccine, and it was found that the former produced larger and finer pustules than the latter, though their evolution was slower. Lafosse designated the disease the *maladie pustuleuse vaccinogène* of the horse.

Bouley, then professor of clinic at the Alfort Veterinary School, not quite satisfied with what had been done in this direction by Lafosse and others, resolved to inoculate cows with all the eruptive maladies of the horse which his daily routine of professional duty brought before him ; and, singular to relate, the very first case (in 1863) was a successful one, and produced a beautiful Cow-pox. The horse presented the following symptoms :—On the inner surface of the lips, on the inferior aspect and free portion of the tongue, on the buccal and gingival membrane, and on the floor of the mouth—particularly along the Whartonian ducts,—were infinite multitudes of small vesicles about the size of a pea, some circular, others elongated, and whose opaline tint was in marked contrast to the bright-red mucous membrane on which they were seated. These pearl-tinted vesicles were smooth on their surface, had no depression, and felt rather tense ; pain was evinced when they were pressed upon. In some places they were confluent, in others discrete. When they had been ruptured, there were small, lenticular, very red sores, with sharply-defined borders. A very abundant saliva, rendered frothy by the incessant movement of the tongue, filled the mouth, and escaped in long masses from its commissures. With the exception of not eating so well as usual, the horse appeared in good health. The symptoms were so different from those described by Loy and Lafosse, that Bouley thought it was an aphthous Stomatitis, and that therefore, like the Foot-and-Mouth Disease of bovines, it must be contagious. True to his resolve, he inoculated a cow to see what the result would be, and produced veritable Cow-pox, from which children were most successfully vaccinated. For some months other horses were admitted to the clinic of the school suffering from the same disease, which varied in its symptoms only with regard to the seat of eruption, which was in some instances as in the first case, and in others as in Jenner's, Loy's, and Lafosse's cases. From these multiplied observations and experiments, most carefully watched and discussed by the most eminent medical and veterinary authorities in Paris, there could no longer exist the shadow of a doubt as to the nature of the disease, which was accordingly designated "Equine Variola" by Depaul, and "Horse-pox" by Bouley himself. Bouley confesses that for years he had met with the disease

among horses from time to time, but until Lafosse's experiments at Toulouse he had not suspected its variolous nature.

From time to time outbreaks of the disease have been recorded in France, where it appears to be most prevalent in Paris and its neighbourhood.

So long ago as 1853, I witnessed, in Manchester, a case of inoculation of a farrier who had shod a horse affected with "Grease." The vesicle was situated on the chin, and there was great constitutional disturbance.

In "Veterinary Sanitary Science and Police" I have devoted a chapter to it, and in the periodical edited by me, the VETERINARY JOURNAL, I have alluded to it frequently (particularly in vol. v., p. 81; vol. vii., p. 371; vol. ix., p. 204). A translation is also given of an interesting report by Professor Ellenberger, of the Berlin Veterinary School, of an outbreak of what he describes as "Stomatitis pustulosa contagiosa," but which was really Horse-pox. In this respect the ready communicability of the disease and its vaccinogenous character is well shown. In a recent number of the *Deutsche Zeitschrift für Thiermedizin*, Professor Friedberger, of the Munich Veterinary School, furnishes an excellent account of an outbreak in that city, and a record of successful experiments. A translation of his paper appears in the VETERINARY JOURNAL for September, 1880. In German and Italian veterinary literature similar outbreaks are described. For the past two or three years there has prevailed widely among horses in England, Ireland, and Scotland a pustular exanthem, very contagious in its character, and known among grooms and others as the "boil disease," the "American boil disorder," etc., which, in some of its features, if not in all, somewhat resembles Horse-pox. The eruption in the majority of cases is mainly confined to the trunk. From England it has been carried to Belgium, where it has attacked a large number of horses. Horse-pox has also prevailed as an epizooty for two years, and is now prevalent, at Montreal. Many persons have been accidentally inoculated, and the vacciniferous character of the disorder has been established by medical and veterinary authorities. The outbreak is described in the VETERINARY JOURNAL for August, 1877. Last October, immediately before leaving my late regiment, the Second Life Guards, I had four cases of the disease among young horses just joined, and my farrier-major was accidentally inoculated on the finger. Surgeon Hensman of the regiment considered the case one of severe vaccination. The details are recorded in the VETERINARY JOURNAL for March, 1880.

So that since 1864, when the nature of Horse-pox was for ever settled by the observations and experiments of Bouley, and the discussions that ensued thereon at the Paris Academy of Medicine, the history of the malady has been largely supplemented by contributions from observers and experimenters in Europe and America, and Jenner's statement has been admitted by all who have studied the subject to be true except in one particular—the "Horse-pox" or "constitutional Grease" being the source of Cow-pox. In this only was Jenner in error. The two diseases are perfectly independent of each other. Cow-pox appears where there are no horses, or possible contact with horses, and where the men who attend upon these do not milk

cows. It has frequently been observed that Horse-pox prevails on a farm or in a locality, and no Cow-pox is seen there ; while the last-named disease may affect a number of cows in a dairy, and the horses be entirely free from Horse-pox. Hering, for instance, states that Cow-pox is very far from rare in Wurtemberg, while Grease (*Mauke*) is extremely uncommon ; that men who work horses do not milk the cows, this office being undertaken by women in that essentially milk-producing country ; and that the majority of the proprietors of cows which had been affected with Cow-pox had no horses.* In none of the recorded outbreaks of Horse-pox has anything ever been said as to the existence of Cow-pox, and no attempt has ever been made to establish a relationship between the former and human Variola, from which it differs as widely as the latter does from Cow-pox. Horse-pox prevails entirely independently of Small-pox or Cow-pox. In some countries it is often present as an epizooty—as in Lower Canada ; while in other regions, where it is enzootic, it will be more common in one part than another—as at Paris, where it is well known, and at Lyons, where, according to Chauveau, it is not seen.

I have already alluded to the results of Small-pox inoculations on the horse, and shown that, as on the ox, they were either negative or nearly so, the positive results yielding only the most trifling evidence of infection, and nothing at all like Horse-pox being ever produced from the insertion of the Small-pox virus into the skin of the horse, while re-transmission to mankind only gave rise to Small-pox. On the contrary, as we have seen, Horse-pox inoculated on the cow produces what in every way corresponds to Cow-pox, or on man to Vaccinia. From the cow and man Horse-pox can be transmitted indefinitely ; and while its action is modified by repeated transmissions, its protective influence against Variola is undiminished. This has been demonstrated times almost without number, from the days of Jenner up to the present date. The most interesting and instructive of recent demonstrations in this direction is that recorded by Dr. Pingaud, in a communication presented to the Paris Academy of Medicine a few months ago. Having observed, with Drs. Viseux and Thomas, an epizooty of Horse-pox in February, 1879, he determined to make some experiments, and selected as a vacciferous subject a four-years-old horse affected with the disease, but whose antecedents were well known, and whose health at other times was excellent. The cutaneous eruption was discrete ; there were only a few crusts of pustules about the hollow of the pasterns ; but in the mouth, and within the upper lip, the mucous membrane was studded with vesicles offering the characteristic nacreous aspect. Lymph was collected from these pustules with the greatest care, and seven young soldiers of the 10th Hussars, who had not been vaccinated, were inoculated. On the sixth day six of the men showed at the seat of inoculation the characteristic vaccine vesicles, which had a somewhat inflamed base. From four of the soldiers lymph was taken ; with this sixty-four men—eight of whom had not been vaccinated—were

* "Gewiss der grosste Theil unserer Eigenthümer von Kühen mit originären Pocken hat gar keine Pferde." *Op. cit.*, p. 9.

inoculated. In forty of these the result was positive—60 per cent. successful vaccinations. With none of the patients were there any serious inflammatory symptoms, and only in a very small number did the inoculations assume a furunculous aspect. Calves were inoculated from the horse, but the proportion of successes were only 48 per cent., rather going to prove that the virus became weakened in the calves.

On May 5th, 1880, a case of Horse-pox was discovered in Paris among the horses of a German horse-dealer. A three-months-old heifer was inoculated on May 5th, with matter from this horse, the inoculations being made by three punctures on the udder. The result was a complete success; and from this animal another heifer was as successfully inoculated on the 13th of the same month. On the 19th there was a very fine vaccinal eruption, no fewer than sixty pustules being developed. Two other heifers were vaccinated from these, and so abundant was the lymph on the consecutive eruption that the Société d'Hygiène was well supplied with material for vaccination purposes. In September of this year also, there was so severe an outbreak of Horse-pox among the race-horses at Chantilly, near Paris, that several of them had to be struck off their engagements.

I have stated that Horse-pox and Cow-pox are almost, if not quite identical in their effects, when transmitted by inoculation to man, the ox, or the horse. Chauveau inoculated five horses and two asses with animal vaccine from Naples; the youngest animal was seven years old, the others from sixteen to twenty years of age. For five and six days there were no signs, but in from five to eight days the seat of puncture became markedly papulous, the papules increasing in size until about the tenth day, when they were acuminated, had a very broad base, and were red, painful, and hard. From the ninth to the twelfth day was the period of secretion, the epidermis becoming slightly raised throughout the whole extent of the papule by an exudation of limpid citron-coloured serum; this dried into yellowish transparent crusts, very different in appearance from those of *Vaccinia* in man or cow. The secretion from the lymph continued for several days, and ceased from the thirteenth to the seventeenth day. When the crust was removed there appeared a moist granular red surface level with the skin, but having a deep central cavity, a kind of umbilicus, in which had been fixed, like the head of a nail, the prominent under-surface of the crust. There was no febrile reaction. In the asses there was shedding of the hair and epidermis in various parts, with abundant serous exudation. As compared with its evolution in man and the cow, the vesicle or pustule was slower, and there was a difference in its shape and character, the pustule being acuminated, the lymph scanty, and the umbilicus small or altogether absent; though in an ass sixteen years old the pustule had from the commencement a central umbilicus. In the horse the crust extends over all the pustule, while in man and the cow only the centre is covered. In the ox the lymph is rarely abundant, and there is never anything more than a thin brown crust; but in the horse the crust is wide, thick, rough on the surface, and transparent and citrine-tinted.

Before leaving the subject of Horse-pox, it may be observed that Spinola remarked that the low-lying regions along the Baltic appeared to be more infested with the disease than elsewhere.

SHEEP-POX.

Sheep-pox differs from Cow and Horse-pox in having a history extending over some centuries, and closely resembling Small-pox in its extension—this depending not only on its contagious but also on its infectious properties—and the eruption being more or less general over the body. Indeed, so far as intensity of virulence is concerned, its appearing in an epizootic form, as well as the serious symptoms and mortality accompanying Sheep-pox, there is the closest resemblance between it and human Variola. We have seen that Cow-pox and Horse-pox are far from being serious disorders, the affected animals, in the majority of instances, being very little, if at all, disturbed in health, while the diseases are not infectious, and not always very contagious.*

In the first portion of this paper, I alluded to Sheep-pox being mentioned at the Vaccination Conference, and observed that it was there admitted that the sheep had a Variola of its own. On again looking over the report of that meeting, it appears doubtful whether the speaker who referred to it thought it was peculiar to the sheep, or whether it was not also derived from human Variola. The best proof that it has no relationship whatever to Small-pox, is to be found in the fact that it prevails continuously, and sometimes most extensively and fatally, in countries where Small-pox is extremely rare, as in East Prussia; and in regions where the latter is never absent, and is often epidemic, Sheep-pox is only known as an imported disease. In England it is never seen unless introduced from countries where it is enzoötic. The terrible outbreak which ravaged our flocks in A.D. 1276, and continued twenty-eight years, was due to importation from France; and the appearance of the disease in 1847 and 1862 was due to foreign sheep. It has been unknown in the country since the latter date.

* Depaul believed Horse-pox to be infectious, and cites, in support of his opinion, an instance in which a cow was inoculated with the lymph from the nostril of a horse, when seventeen other cows inhabiting the same shed were soon after infected, Cow-pox pustules appearing on the udder and teats. In addition, a horse kept in a badly-constructed box in this stable, and breathing the same atmosphere as the cows, was also affected, the eruption showing itself on different parts of its body. It is not at all improbable, however, that the cow-keeper and his assistants, who handled the diseased and healthy animals alike, were the chief agents in spreading the malady. Indeed, the wife of the cow-keeper, in milking the cows, was vaccinated on one of her fingers, and yet continued to handle the teats of the others, notwithstanding the pain she experienced. Bouley has had perfectly healthy horses and cows cohabit with diseased horses, and when the malady was produced in them he was always able to trace it to direct contact. During the epizooty at Alfort, in 1863, it was possible to transmit the Horse-pox to a series of horses by placing them one after another in a stall which had been occupied by a diseased horse. Each animal became affected in turn, and at times its immediate neighbours also; but beyond those in that stable there were no further transmissions, all the other horses remaining unaffected. As Bouley justly remarked, a really infectious disease does not comport itself in this manner. Veterinary-surgeons Turenne and Mathieu have also experimentally demonstrated that Horse-pox is not infectious, and this is in accord with my own experience.

Notwithstanding the close resemblance of Sheep-pox to Small-pox (the pustules in the former being, however, acuminate, but the course of the malady is very similar, the complications the same, and the mortality as great), yet the one disease has no influence either in the production of or protection from the other. It appears to be finally established that human Variola will no more produce Sheep-pox than it will Cow-pox, notwithstanding the close affinity between the two; and while variolation will not protect from Sheep-pox, neither will inoculation with the virus of the latter prevent mankind having Small-pox.

Some authorities have denied that ovine Variola can be transmitted to the human species; and the extreme rarity of cases of supposed accidental transmission certainly gives countenance to the opinion. But several instances are recorded, nevertheless, of veterinary surgeons who have been accidentally inoculated with the virus, suffering from local and general disturbance, like that produced by vaccination.* Kornert† reports that a child who tended (barefoot) sheep affected with Variola, had a number of discrete and confluent pocks on both feet. This transmission occurred also to one of Korner's own children. On the back of the boy was developed a pock, which finally became as large as a five-pfening piece; there was severe concomitant fever. The child appears to have been inoculated while Korner was charging some capillary tubes with Sheep-pox lymph from a pipette, a drop of the fluid, it is supposed, having fallen on him.

Röll has unsuccessfully attempted to inoculate cattle with Sheep-pox, and sheep with Cow-pox; but Zundel‡ has given an instance in which two cows were directly infected through cohabitation with diseased sheep. Haubner mentions that inoculation with Small-pox matter has sometimes produced pustules on the dog and pig; but reinoculation from these did not cause the malady in sheep. Hertwig and Hering assert that the malady is readily communicated to goats in a true form, and may be transmitted from them to sheep. In the goat the pustules are usually smaller, according to Giesker, and the general disturbance is less marked. But transmission is very far indeed from certain, as goats very often associate with sheep without becoming affected. Hering knew of an instance in which fifty-four goats grazed with diseased sheep, and only ten became sick. According to Kersten, Lenhardt, Spinola, and Gerlach, reciprocal inoculation of goats and sheep is always successful; while according to the observations and experiments of Gasparin, Dominick, Curdt, and Spinola, and, still more recently, Gerlach, there appears to be a close identity between the Variola of hares and rabbits and that of sheep, inoculations from one species to the other always yielding positive results.

Sheep have a kind of Variola known to the Germans as "Steinpocken" or

* See "Medizin. Jahrbuch des Oesterreich. Staates"; also "Mittheilungen aus der Thierärztlichen Praxis in Preussen," Jahrgang 17; and "Magazin für die gesammte Thierheilkunde," 1873, p. 467.

† "Mittheilungen aus der Thierärztlichen Praxis in Preusschen Staate für 1876-77 und 1877-78."

‡ "Journal de Méd. Vétérinaire de Lyon," 1867, p. 185.

"Aaspoeken" (*Variola tuberculosa*, *Varicella ovium*). It has been described by Haxthausen,* Hoftrichter,† and Hering.‡

When vaccination as a protection from Small-pox began to gain ground, as its benefits were becoming more and more evident, many of the leading veterinarians on the Continent tried it as a protective against Sheep-pox; but they soon discovered that vaccinated sheep were as susceptible to their own particular *Variola* as the unvaccinated. Verrier, Gohier, Husson, Voison, and other veterinary surgeons, found that, no matter how successful the vaccinations had apparently been, the sheep took the disease, either accidentally or experimentally, as readily as before. For this reason vaccination is never attempted now, as it does not confer immunity from Sheep-pox—a curious circumstance with regard to inter-variolization among different species of animals.

The contagium of Sheep-pox is very active, as has been already stated. The observations and calculations of Chauveau with regard to the infectiousness of the malady, compared with that of *Vaccinia*, tend to prove that animals attacked with Sheep-pox will infect a hundred times more readily than those affected with Cow-pox. The Sheep-pox lymph also, according to the same authority, contains in an equal volume and weight a much more considerable number of virulent corpuscles, and is much more potent than that of *Vaccinia*. He has shown that if the latter is diluted with fifty times its weight of water, inoculation with it is uncertain in its result, while the Sheep-pox matter may be diluted with 1500 times its volume of water before it is reduced to the same condition. He has also demonstrated that the activity of this matter, like that of every other virulent substance, resides in the solid particles or elementary corpuscles held in suspension in the serum which is not viruliferous; and that an equal quantity of Sheep-pox lymph contains thirty times more of these particles than that of *Vaccinia*.

It may be remarked that in Australia, New Zealand, and the American continent, Sheep-pox has never been seen, because it has not been carried there. Yet human Small-pox, imported from the Western world, is as prevalent in those regions as with us. This should be convincing proof that there is no relationship between the two *Variolæ*, so far at least as their contagious principles are concerned.

GOAT-POX.

The goat has a *Variola* of its own, which possesses as special and distinctive characters as that of the animals I have already described, and is entirely independent of infection from other species. In some countries this *Variola caprina* is apparently unknown, in others it is extremely rare, while in at least one country, Norway, it is a frequent, if not a continuous disorder amongst the caprine population. I am not aware if it has ever been witnessed in this country, where goats are so few in number. For Germany,

* Rust's Magazine, Band 29.

† Henke's "Zeitschrift," 1831.

‡ "Specielle Pathologie und Therapie für Thierärzte," p. 389.

Hering says the disease is rare.* Hertwig† describes an outbreak, and gives illustrations of the eruption. The animals were at first unwell, and there was diminution of the lacteal secretion, with great sensitiveness of the udder—the goats had been in milk about three weeks. The first pock was seen on the udder, and on the fifth day was the size of a pea, standing about two lines above the skin, flat, apex rounded, moderately red, with a small areola, which increased in size. Two or three days afterwards the pocks were reduced to the size of a hemp-seed, pale-red and firmly adherent to the skin. On the tenth day they were quite dry and covered by a thick brown crust, which on the eighteenth day fell off, leaving a cicatrix. The disease had much more resemblance to Cow-pox than to Sheep-pox. Spinola, in 1847, witnessed a similar outbreak, the eruption being most visible on the udder. In September, 1832, the disease appeared among a drove of goats (54), in Geislingen, attacking first seven, then three of the number. In some of them there was fever at the commencement, then the eruption of pustules; though generally there was little constitutional disturbance, and only diminution of milk, with soreness of the mammæ before the pocks appeared. Sheep in contact with these goats were not affected.‡ But Bollinger says it is so infrequent, that in the course of twenty or thirty years scarcely half a dozen cases are recorded. He is of opinion that goats receive the disease either from cattle affected with Vaccinia, or sheep suffering from Sheep-pox. But he admits that though now and again the same form of Variola is witnessed in cows and goats, yet that the latter, as a rule, remained exempt from the disease when confined in the same stable with infected cows, and that the inoculation of goats generally yielded negative results. In order to prove that goats may be infected with Sheep-pox, he gives the following on the authority of Prietzsch: "In a stable in which sheep suffering from Sheep-pox were confined, three goats were simultaneously attacked with the disease, the eruption being the same as in the sheep. Upon the udder were numerous pisiform variolæ in the form of hard, flattened papules, with a trifling amount of lymph; papules were also distributed over the body, being more numerous upon the hind extremities than the abdomen. Marked symptoms of fever were also present, with inappetence, swollen lips, and a somewhat profuse muco-purulent discharge from the nostrils. In fourteen days convalescence was established. Two other goats were inoculated on the ear with the virus of Sheep-pox; a single pustule formed at the seat of inoculation, and the animals did not afterwards take Sheep-pox."

That there is no relationship, so far as origin is concerned, between Sheep-pox and Goat-pox, nor yet, for that matter, human Variola, is evident if we look at a country where the latter is all but unknown, and the former is not seen. From 1864 to 1876 inclusive, Sheep-pox has been reported only twice in Norway; in 1865 there were two cases, and in 1868 fifteen cases, all due to foreign importation. According to Hansen, the official veterinary surgeon

* "Specielle Pathologie und Therapie für Thierärzte," p. 389.

† "Magazin für Thierärzte," Band vi.

‡ *Op cit.*, 1856.

in central Norway,* in 1867-68-69, and 1874 and 1875, extensive outbreaks of Goat-pox were observed; and according also to the official veterinary statistics in 1865, eleven cases of the so-called "Water-pock" (*Variolæ serosæ*), and in 1868 four cases of common Goat-pox were recorded in South Norway. Many cases which escape the notice of the Government veterinary surgeons are supposed to occur. In 1871 Dr. Cæsar Boeck, of Christiana, was on a botanical excursion in South Norway, and in July, in Thelemarken, he saw a drove of cows and goats being driven from the woods into their huts. The cattle were quite healthy, but about forty of the goats were affected with a variolous eruption on the udder and teats, as well as about the mouth. In some there were merely deep dark-coloured sores remaining, in others—the majority—there were seen thick brownish crusts, about the size of a pea, on the mouth, udder, and adjoining parts; while in a few the disease was so recent that, with the crusts, there were also observed pustules from the size of a lentil to that of a pea. From inquiry and examination, Boeck was of opinion that the exanthem had been more or less general over the body, and that there had been fever and resulting emaciation. The milk secretion had been almost diminished, and the fluid itself was drawn with difficulty and pain. None of the goats had died, and no other animals had, so far as the shepherdess knew, been in contact with her drove. The cows were fifty in number, and none of them showed the least trace of disease. The cows and goats were milked indiscriminately by three women, whose hands were not washed from the commencement to the end of the operation; so that there was abundant opportunity for transmission of the disease from the goats to the cows, had the latter been susceptible; while the constant association of the two species, particularly in the closely-packed sheds, gave every facility for infection through the medium of the atmosphere, if this could have taken place. Experimental inoculation would have been tried, but no good lymph could then be found. The epizooty appeared in the spring, among the four-year-old goats which had been kept during the winter by themselves in small sheds. When they joined the other goats at a later period, the outbreak became general in a short time. Flocks of sheep associated with the goats without any disease resulting in them. Sheep-pox—a very fatal disease—had never been seen in that part of Norway. Boeck, who contributes his observations to the *Deutsche Zeitschrift für Thiermedizin* for December, 1879, alludes to veterinary-surgeon Hansen's observations with regard to the outbreaks in 1867-68-69, and 1874-75, in Gudbrandsdalen. In the first year the malady appeared in August in two different flocks, numbering 170 goats, attacking without exception the males, kids, and those in milk. In the males the eruption was sparse, and limited to some pock pustules on the scrotum. (In the following year, the exanthem on the males extended to the inner surface of the thighs.†) Hansen was called in when thirteen of the 170 goats had

* Gudbrandsdalen d. h. Gudbrandsthal.

† From this it will be seen that the male goats are as liable to the Goat-pox as the females. It is the same with the rams associating with flocks of sheep, and which suffer as much as the ewes; and it would be the same with bulls or bullocks, did they consort with cows affected with Cow-pox. Sex makes no difference.

died, and nearly all the others were affected. On examination of two of the carcasses, he found the eruption all over the body, and pustules and ulcerations on the mucous membrane of the stomach and intestines, as is often witnessed in malignant Sheep-pox. The origin of the outbreak could not be accounted for, the goats not having been in contact with strange animals, and there was no similar disorder prevailing among other creatures. "I have practised in Gudbrandsdalen," says Hansen, "for twenty years, and I have never seen either Cow or Sheep-pox." In the goat-sheds were sixty cows and eighty sheep, but these remained healthy.

In June, 1868, in another district of the same parish, Hansen was sent for to see a herd of goats, and of 114 eighty-four had an eruption of pocks on the udder and teats ; twenty were severely affected, and, in addition to the pocks on the lacteal apparatus, there were many on the inner side of the thighs and on various parts of the abdomen, some of them having ruptured and left large sores. The pain was so acute during milking that the animals cried and struggled, and had to be held. The milk was rather viscid and mixed with blood. The disease existed in all stages among the animals, from red spots to shedding crusts and the formation of cicatrices. The outbreak had only occurred eight days previously. Thirty animals were yet unaffected, and these were isolated. The neighbouring goat-farms were free from the malady, and Hansen could not account for its presence on this farm ; but as it was only distant about half a mile (Norwegian) from the place where it prevailed the previous year, it might have been conveyed from there. In July all the goats on the farm had been infected ; at the commencement of August Goat-pox had nearly disappeared, and during the entire period of the outbreak the cattle there and in the neighbourhood had continued healthy.

On August 17th of the same year, Hansen was again called to attend upon goats at another place, not far from the last, where there were seventy-four goats, only thirteen of which were free from Goat-pox. Twelve were severely affected, and three were so ill that they could not follow the others. The pocks on the udder, teats, and thighs could be studied from the first or inflammatory stage to the crust-forming and cicatrising period, the cicatrices being distinguishable from ordinary scars by their light hue. The diminished secretion of milk and the emaciation were very marked, though the malady was not so fatal as in the previous year. On four neighbouring farms the disease also appeared among the goats.

When the disease once appeared in a flock it spread rapidly, and spared neither young or old, male or female ; those goats giving most milk having, however, the mildest attack, and the males having the pock-pustules most developed on the inside of the thighs. The contagium might have been conveyed to these farms by direct contact with the first infected farm, or, as was more probable, through the medium of servants and children. In the following month a number of other farms were visited by the Goat-pox. Some of the goats had phlegmonous inflammation of the udder as a consequence of the disease, and had to be killed.

In 1869 two herds of goats were attacked, but timely and careful treatment

having been adopted the results were not so serious. The milch goats were the worst attacked, and the mortality was greatest in the largest herds. The total number of cases for this year was 129. In the four succeeding years Hansen did not know of any outbreaks.

In July, 1874, Goat-pox broke out in two different districts, one and a half Norway miles apart, three farms being visited by it—one with 150 goats, another with 120, and the third with 60. All of these were more or less affected. The disease first commenced with slight fever; then followed efflorescence, subsequently the eruption on the udder and teats of small vesicles the size of a pea, and which soon became converted into pustules. Not unfrequently suppurating furunculi formed, and the whole udder was involved.

In some instances pocks appeared on the lips. Towards the end of August, there were reported 580 cases of Goat-pox in the two localities. On the neighbouring goat-farms the disease was not seen. There was no evidence that it could be communicated to mankind, though it appeared not improbable that mankind could convey it from one flock of goats to another. Ten deaths only were reported. In 1875 there were 200 cases. Hansen states that altogether there were 1,300 goats attacked, with from twenty-five to thirty deaths—about two per cent. The incubative period appeared to be short, certainly not longer than a week, while the duration of the disease was from two to three weeks in the severer cases. The pock cicatrices were more or less stellate-shaped. Immunity was very rare indeed, nearly every goat exposed to infection taking the disease. The outbreaks always occurred during the summer months, and the epizooty did not extend beyond Hansen's official district. Boeck and others competent to judge had no doubt whatever that the disease was Variola. Neither sheep nor cattle, notwithstanding their constant exposure to infection and being crowded with the goats in close sheds, became affected. Human Variola was not present in the district during the years when Goat-pox prevailed.

I have entered into these details with regard to Goat-pox, because they support in the strongest manner the position I have taken up with respect to Variola in man and animals, and prove that, inasmuch as we have shown that there is a Cow-pox, a Horse-pox, and a Sheep-pox, there is also a Goat-pox, independent of the Variolæ of other animals.

SWINE-POX.

Swine-pox is not a very rare disorder, and though I fail to find more than one outbreak recorded as occurring—though outbreaks may be frequent—in this country, yet I have been assured by a very observant and competent veterinary surgeon that he saw a large number of swine suffering from the disorder in Kent. No Small-pox or Cow-pox was present in the locality. Like the ovine Variola, the *Variola suilla* is a general eruptive disease, the symptoms being pretty constant in their development, and resembling those of Sheep-pox. After the febrile phenomena, which are often very intense and continue for some days, there appear on the back, abdomen, chest, neck, head, and inner surface of the thighs, petechiæ, which soon become papules.

Towards the sixth day there are vesicles, and about the ninth or tenth day, pustules; the contents begin to desiccate and form crusts, which are eliminated in a few days, leaving a well-defined cicatrix. The eruption appears discrete and confluent, the disease being benignant or malignant, regular or irregular, according to the form it assumes. Young pigs are most susceptible, and the mortality often reaches twenty or twenty-five per cent. Hering has seen the disease in older swine. The malady is very contagious, and its course and complications, as well as infectiousness, are very closely analogous to those of Sheep-pox. One attack protects from another. Felix (*Recueil de Méd. Vétérinaire*, 1827) describes an outbreak which prevailed among swine in the Dordogne department, during four years; and Rueling,* Greve, Spinola,† Viborg,‡ Pozzi, Gasparin, Eisele,§ Hering, and other competent veterinary authorities have studied Swine-pox at various times. Gerlach has experimentally proved that the disease can be transmitted to sheep, and the Sheep-pox to pigs. Cases of accidental transmission from sheep have been recorded. Bollinger mentions that some young swine were attacked after being lodged in a pen where diseased sheep had been located some months previously, and these pigs communicated their malady to others which had not been in the shed in question. But that there is no genetic relationship between Swine and Sheep-pox is again proved by reference to Denmark, where the latter does not exist, and where, nevertheless, Swine-pox is sometimes prevalent, as in 1878, when it appeared in several localities in Jutland, according to the veterinary sanitary reports of that kingdom. The same evidence could be given with respect to other countries. Viborg, Spinola, and Hering have proved that the disease is readily inoculable to other pigs. Rueling, Viborg, and Hering have not been successful in transmitting Swine-pox to the horse or cow; though Gerlach succeeded in inoculating a goat. The transmission of Swine-pox to mankind has been sometimes noted. Arnsberg|| for instance, knew of three persons who had been infected; and Roell gives similar evidence. Accidental transmission of human Small-pox to pigs has been recorded now and again, and that this transmission may take place, I do not deny; but it certainly does not prove that Swine-pox is dependent for its origin on Small-pox. The former occurs where the latter is not present, as in Denmark, and Small-pox may rage for years in districts where pigs are numerous, and the latter show no signs of Variola. In the Würtemberg reports for 1877, mention is made of the prevalence of the "wild" or *Wasserpocken* (*Variolæ serosa*) among suckling swine. These pocks soon burst, and their contents mixing with the milk, were ingested by the young pigs in the act of sucking. These had in a short time a yellowish-brown eruption, first about the eyes and nose, and then over the entire body. When the eruption was noticed early, and the young pigs were then removed from the sows, the consequences were not so serious; but when the exanthem

* Physikalisch Medicinisch, Oeconomische Beschreibung der Stadt Nordheim, 1779.

† Schweinkrankheiten, 1842.

‡ Behandlung des Schweines als Hausthier, 1804.

§ Krankheiten der Schweine.

|| Gurlt und Hertwig's "Magazin für Thierheilkunde," Band x.

extended over the entire body, they quickly died. Bathing them in bran water or camomile tea was supposed to have cured a good number. No mention is made of Small-pox among people. In 1878, according to the *VETERINARY JOURNAL* (vol. vii., p. 210), there was a serious outbreak of Swine-pox in many localities in the Hernals and Baden districts. It first appeared among swine of Hungarian origin imported from Odenburg, and from them was communicated to the native herds. The mortality was unusually great. The conditions attending the appearance, course, and termination of the disease were precisely analogous to those which obtain in Sheep-pox, and the veterinary sanitary measures in force for the latter were adopted successfully for the Swine-pox. No mention is made of Sheep-pox, Cow-pox, or Small-pox prevailing at the time.

DOG-POX.

In the dog, Variola has been observed and described by many authorities, and is, in fact, a comparatively well-known disease to veterinarians. It chiefly attacks young dogs, though old ones are not exempted, and one attack affords immunity from others. *Variola canina* commences, as in other animals, with fever, which continues for two or three days, and is then followed by the appearance over a large surface of the body, though rarely on the back or sides, of red points resembling flea-bites, which in a very short time are the seat of papules, and then of vesicles. The contents of these become purulent, and finally dry into a crust, which, being shed, leaves a marked cicatrix. In the dog, as in the sheep, goat, and pig, the disease does not always maintain the same form; it is sometimes epizootic, and is benignant or malignant. Young dogs nearly always succumb, and a necropsy often reveals the presence of variolous pustules on the mucous membrane of the respiratory and digestive organs. The disease does not appear to be very infectious, though it is contagious and inoculable. It appears to be communicable to mankind, for Bösenroth* saw the disease affecting dogs around the nose, face, eyes, and back, and the attendant became infected. The dog does not appear to be very susceptible to the Variolæ of other animals, nor yet to that of man. I can find few instances mentioned in which Small-pox was communicated to this creature, notwithstanding its very close association with mankind, and consequent exposure to infection.† Greve inoculated eight dogs with the matter of human Small-pox, and three of them became covered with pustules and died. Vaccination only develops insignificant bullæ containing pus; scarcely any "pit" remains.

I am not aware that Variola has ever been observed in the cat.

* *Magazin für Thierheilkunde*, 1860, p. 341.

† The supposed cases of transmission are not at all conclusive. They are generally of the same kind as that detailed by a writer (G. A. C.) in the *Field* for September 2nd, 1871. "Two or three members of the family of a person who was rearing a beagle for me, were ill of Small-pox, and some of the bedclothes were being steeped in water preparatory to washing them. The beagle was seen to lap some of the water, and in a few days he died, covered with Small-pox. Cases of dogs taking the disease have happened, I believe, but very rarely."

CAMEL-POX.

The camel has long been known to suffer from Variola. Agnelli, in 1850, observed an outbreak among camels in Algeria, the symptoms of which were like those of Cow-pox, especially when transmitted to mankind. When the Arabs were inoculated with the lymph they were protected from Small-pox. Masson* makes similar remarks with regard to the camel in India. He mentions the accidental and artificial transmission of the disorder to the human species, and states that when children were inoculated from the camel they had a more or less general eruption, which was nearly always malignant, exceptionally mortal.

In an unpublished, but most interesting report just to hand (March 1st, 1881), drawn up for the Indian Government by Army Veterinary Surgeon Oliphant, as to the sanitary condition of the various kinds of animals employed during the recent campaign in Afghanistan, I find the following valuable confirmation of Agnelli and Masson's statement. Mr. Oliphant, in describing the diseases of camels, writes: "I noticed on several occasions, but more particularly at the camel camp at Tagh, a well-marked and highly characteristic outbreak of Variola. Circular raised vesicles contained limpid fluid, which gradually assumed a turbid aspect; the pustule dried up, cupping in the centre, and forming a yellowish-brown scab which finally separated, leaving a well-defined pit, more or less permanent, but difficult to find when contraction had taken place and hair had grown around it. When confluent, or injured by rubbing—for intense itching was a marked characteristic—extensive sores were created, and several animals had to be destroyed on this account. In many cases, the disease ran its course in a mild manner, and by keeping the affected animals as far separated as possible, it did not become widespread. However, in examining camels, I frequently came across the scars. In connection with this, I may add that a camel-driver presented himself to me with undoubted Small-pox which, he stated, he had caught from the camels, and which his comrades seemed to consider a common occurrence. They also recognised the disease by the ordinary name of 'Màta.'"

VARIOLA GALLINARUM, ANSERUM, ETC.

Fowls have also their Variola, according to the reports of various observers, published during many years. Bollinger has investigated what was supposed to be Variola in a poultry-yard at Zurich, but found it to be a contagious epithelioma, chiefly localised upon the head. But what appears to be a true Variola has often been studied in fowls, as the loss it caused was very great, and its contagiousness caused it to be widespread. In these outbreaks the birds were dull and feverish; the feathers stood erect; the wings and tail were pendulous, and an eruption of pustules appeared on the head, neck, and inner surface of the wings and thighs. In the turkey they appeared as citron-tinted vesicles, surrounded by a red areola. In from

* Narrative of a journey to Khelat, Trans. of Med. and Phys. Soc. of Bombay, 1840, p. 214.

twelve to fifteen days after their development these pustules became crusted, the fever disappeared, and health gradually returned. In geese the pustules on the neck not unfrequently increased in size and formed abscesses; the feathers were shed, pieces of skin even became detached, and the resulting lesions were so serious that death was not an unusual termination. The disease was very contagious.

In the official report on the sanitary condition of the domesticated animals in Belgium during 1878, I find that Government Veterinary Surgeon Déjonghe, of Wyngene, describes this Variola of poultry. It prevailed as an intense enzoöty during the last half of 1878, frequently attacking all the fowls on a farm, and being most prevalent in low, damp situations. It was markedly contagious, or rather infectious, and the prevailing winds had apparently some influence in its dissemination. Young birds suffered most seriously, and bad food aggravated its severity. The earliest observed symptoms were erect plumage (horripilation), complete indifference, *malaise*, and general prostration, anorexia, great thirst, ardent craving for cold water, and rapid emaciation. There appeared on the skin and visible mucous membranes numerous small nodules, which were soon transformed into pustules. Most frequently these pustules soon after their appearance ruptured, fetid matter escaped, and only superficial sores remained; these generally cicatrised rapidly. Where the skin was thick, cicatrices, often deep, remained. On the respiratory mucous membrane the pustular eruption caused an abundant formation of muco-pus, which sometimes caused death by obstructing the air-passages. Generally, however, a fatal termination seemed to be due to debility, septicæmia, or pyæmia. In birds which survived, complete recovery did not take place for a long time.

VARIOLA IN FERÆ NATURÆ.

To what extent wild animals in general suffer from variolous diseases it is impossible to say, as there is but little evidence, and that not of a very reliable kind. But that they are susceptible of infection, and are the victims of their own particular kind of Variolæ, there cannot be any valid reason for doubting. Hares and rabbits are said to have a form of Variola, especially in North Germany, and which is sometimes very malignant. It has been believed for a long time, in those countries in which Sheep-pox is prevalent, that rabbits receive infection from diseased sheep while grazing in the same pastures; it has even been asserted that entire warrens have been cleared of their inmates by the transmitted disease. Astruc, Paulet, and Gasparin—a French authority and good observer, state that Sheep-pox is frequently conveyed to hares and rabbits; and the observations and experiments of Curds, Dominick, Spinola, and Gerlach, support the statement. Inoculation from one to the other species has always yielded positive results. Hunters and others have occasionally reported wild boars, chamois, and other *feræ naturæ* as affected with an eruption like Small-pox.

The *Simiada*, in an untamed state, would appear to be often attacked with Variola. It has been observed that when Small-pox has been prevalent in the

West Indies, and also in South America, wild monkeys have been affected with a variolic eruption; though whether they were infected from mankind, or whether what is called the epidemic constitution of the atmosphere (a very doubtful influence) also produced an outbreak of Variola among them, it would be difficult to decide.

These creatures certainly seem to be the most susceptible of all animals to the reception of human Variola. Buffon and Barrier give instances of this susceptibility; and so long ago as 1767, it was known to the denizens of Saint-Germain-en-Laye, France, that a monkey became infected with Small-pox through playing with diseased children. A similar instance is related by Paulet, as occurring at Paris in 1770. The two Danish veterinary professors—Abilgaard and Viborg—state that after having unsuccessfully attempted to convey human Variola to cows, horses, asses, sheep, and dogs, they inoculated a monkey with the virus of that disease. The little creature was attacked with Small-pox, the malady offering similar symptoms and pursuing the same course as in man. Diarrhœa set in towards the last stage of the disease, and it succumbed. Three children were inoculated with matter from this monkey, but without result.

Monkeys, it may be noted, have been successfully vaccinated; that is, in them vaccination has offered all the phenomena observed in children.

RESUMÉ.

I have now brought my study of human and animal Variolæ to a conclusion, and, in doing so, may state that, with the materials at my disposal, I have endeavoured, to the best of my ability, to solve some of the difficult problems which always seemed to me to require solution in connection with this deeply interesting and very important subject. The result of my observations and researches incline me strongly to the opinion, an opinion supported by facts, that every species of animal—in the higher orders at least—has its own distinct kind of Variola, and that the Variola peculiar to each species is capable of indefinite existence, transmission, or propagation in that species. But when we attempt to transfer the Variola of one species to another species, then not only do we encounter difficulties, or even failure, but when successful we sometimes find striking differences and peculiarities in the resulting phenomena; whereas in the same species it is capable of easy transmission, and always preserves its own special characteristics. In some species the disease is “infectious” (*volatile virus*, if the expression be admissible), as well as “contagious”—as in man and the ovine, canine, cameline, and porcine species; while in other species, as the bovine, caprine, and equine species, it is merely “contagious” (*fixed virus*), immediate contact or inoculation being necessary for its production. In some species there is great constitutional disturbance, and the mortality is serious—as in creatures the virus of whose Variola is “volatile” (mankind and the sheep, dog, and pig); whereas in others whose Variola is propagated by a “fixed” contagium, there is little, if any, fever noticeable, and the disease is benignant (cow, horse, goat).

Not only is the character of the eruption different in different species (as in man and the sheep and pig, and the cow, goat, and horse); but in some species it is more or less local (*Variola* with a *fixed* contagium), as in the horse, cow, and goat; and in others general, as in the human, ovine, porcine, cameline, and canine species (*volatile* contagium). The disease may, and does, appear in one species entirely independently of its manifestation or absence in other species;* and it may prevail most extensively in one species—as in the human or ovine species—and yet other species manifest no traces of *Variola*. The few instances recorded of the malady having been transmitted from one species to another, must be looked upon with grave suspicion, and particularly those which have reference to the accidental communication of human *Variola* to the cow or horse. There can scarcely be a doubt that the gravest mistakes have been made in this direction; and for evidence of this, we have only to refer to one instance, which, strange to relate, has been quoted not only by medical, but by veterinary authorities in this country, as affording undeniable proof that human Small-pox may be transmitted to the cow, and is the source of Cow-pox. It is the instance given by Ceely, and insisted upon by him as conclusive circumstantial evidence that human and bovine *Variola* are one and the same disease. As the mistake made by Ceely has not hitherto been discovered, I take upon myself the responsibility of proclaiming the error, by reproducing his narrative of the occurrence, and commenting upon it. He writes:—

“At the village of Oakley, about sixteen miles from the town of Aylesbury, Small-pox has been epidemic from June to October, 1840. Two cottages, in which three persons resided during their illness, were situated on each side of a long, narrow meadow, comprising scarcely two acres of pasture-land. One of these three patients, though thickly covered with pustules of Small-pox, was not confined to her bed after the full development of the eruption; but frequently crossed the meadow to visit the other patients—a woman and a child—the former of whom was in great danger, from the confluent malignant form of the disease, and died. According to custom, she was buried the same evening; but the intercourse between the two cottages was still continued. On the day following death the wearing apparel of the deceased, the bedclothes and bedding of both patients, were exposed for purification on

* We have mentioned elsewhere, that Cow-pox may be more frequent in this country than is suspected by those who assert that it is never heard of. Probably, if careful inquiry were made in certain localities where cattle are kept in a somewhat primitive manner, as in some parts of Germany, the occurrence of cases would be found to be frequent. For instance, a correspondent to the *Field* writes in March, 1881: “There was a question put in the House of Commons this week as to whether there was any well-ascertained case of spontaneous Cow-pox on record. The Cow-pox is common enough in this county (Moray). Ask any veterinary surgeon or cow-keeper, and they will tell you the same. I myself know two byres in which the Cow-pox was present last year—one in the town of Elgin, the other on the banks of the Spey, near Aberlour. The dairymaids are well acquainted with it, always milking a cow so affected after the others, so as not to communicate the disease. Beyond the actual pain of the scar making the cow somewhat impatient of milking, it seems to suffer no inconvenience.”

the hedges bounding the meadow ; the chaff of the child's bed was thrown into the ditch, and the flock of the deceased woman's bed was strewed about on the grass over the meadow, where it was exposed and turned every night, and for several hours during the day. This purification of the clothes continued for eleven days. At that time eight milch cows and two young heifers (sturks) were turned into this meadow to graze ; they entered it every morning for this purpose, and were driven from it every afternoon. Whenever the cows quitted the meadow the infected articles were again exposed on the hedges, and the flock of the bed was spread out on the grass, and repeatedly turned. These things remained till the morning, when the cows were re-admitted, and the contaminated articles were supposed to be withdrawn. It appears, however, that the removal of the infected articles was not always accomplished so punctually as had been enjoined ; so that, on one occasion at least, the cows were seen in the midst of them, and licking up the flock of the bed which lay on the grass. These cows were in perfect health when first put out to graze in this meadow, but in twelve or fourteen days, *five* (out of the eight) milch cows appeared to have heat and tenderness of the teats. The teats became swollen, and small, hard pimples could be distinctly felt upon them, as if embedded in the skin. These pimples daily increased in magnitude and tenderness ; and in a week or ten days they rose into *blisters* (vesicles), passing into brown or blackish scabs. When the teats were in this condition, and very tender, constitutional symptoms of ill-health became developed. Sudden *sinking* or loss of milk, drivelling of saliva from the mouth, frequent inflation and retraction of the cheeks, staring of the coat, 'tucking up of the limbs,' 'sticking up the back,' and rapid loss of flesh, were the appearances which even the peasants themselves were able to appreciate. By the middle of the third week the pustules were mature, and the crusts and loose cuticle began to be detached. The simultaneous occurrence of the disease on all the animals increases the probability of the operation of one common cause. The whole of the cows were certainly affected within less than three days of each other ; and another circumstance requires particular notice, namely, the occurrence of the disease in a young heifer (sturk) to which of course the disease could not have been communicated by those casualties which commonly propagate the vaccine Variolæ amongst milch cows. The cause which originated the disease amongst them at the same time affected the young heifer, which hitherto had not been considered liable to the vaccine disease, simply because no one had seen the animal affected by it. Now it is known, both in this country and in Germany, to be liable to the disease.

"The proprietor of the animals referred to in this narrative had the disease communicated to himself. He had never suffered from Small-pox nor the vaccine disease ; and it was his own spontaneous conviction 'that his cows had been infected from human Small-pox effluvia,' to which undoubtedly they had been exposed. He had not the remotest idea of the medical theories concerning the nature of the disease, and consequently had no prepossession in favour of the opinion he thus spontaneously expressed. His cattle

had hitherto been in good health, and no vaccine Variola had been known in the vicinity.*

Now it is easy to perceive, from this description, that the malady the cows suffered from was not Variola at all, but simply Foot-and-Mouth Disease (*Eczema Epizoötica*). The *vesicles*, the *constitutional symptoms*, the *loss of milk*, but, above all, the *drivelling of saliva from the mouth*, *frequent inflation and retraction of the cheeks*, *staring of the coat*, *tucking up of the limbs*, *sticking up of the back*, *rapid loss of flesh*, are all typical symptoms of this epizoötic and now well-known disorder, and certainly not those of Cow-pox. The Foot-and-Mouth Disease was introduced into this country for the first time in 1839, and nothing being known of its history or symptomatology, it caused much astonishment, as well as surmise with regard to its nature. It spread rapidly over the three kingdoms. The prevalence of Small-pox in the village of Oakley, and the occurrence of this bovine plague among the cows, was a mere coincidence; while the almost simultaneous development of the malady in the latter is further proof that the affection was not Cow-pox, nor yet transmitted Small-pox.†

When we consider the question of aptitude of one species to receive the Variola of another, we again meet with marked differences. Some species will readily take the Variola of another species, and retain it unimpaired in virulence through a continuous series of generations, while they will remain stubbornly refractory to the reception of the Variola of a third species; or if they do receive it, it is in an abortive form, and cannot be transmitted beyond the second or third series of animals.

Vaccinia affords us a good illustration of this fact. In a remarkable paper written by Chauveau, and published in 1877,‡ on the vaccinogenous aptitude of the principal vacciniferous species, he gives the following general conclusions derived from an exhaustive experimental study:—

“1. Classical vaccination proves that the three principal vacciniferous species—man, ox, and horse—are equally apt to transmit vaccinia indefinitely, and exhibit a like vaccinogenous aptitude. The horse, nevertheless, is distinguished by the relative frequency of true generalised vaccinal eruptions which, in young animals, may follow cutaneous inoculation.

“2. When, instead of inserting the vaccine virus into the mucous layer of the derm, it is passed into the subcutaneous connective tissue, it manifests its action by two kinds of effects common to the three species: a more or less marked local affection is developed, and the animals acquire *vaccinal immunity* as absolutely as if they had undergone the classical vaccination. This double result is obtained equally well in the three species, so that they are allied, as it were, in the vaccinogenous aptitude.

* Trans. Provincial Medical and Surgical Association, vol. x.

† At the end of 1878, Dr. Klein, experimenting under the supervision of Drs. Seaton, Burdon-Sanderson, and Mr. Ceely, had inoculated sixteen heifers and fifteen milch cows with Small-pox matter taken from people at different stages of the disease, but with negative results.

‡ Contribution à l'Etude de la Vaccine Originelle. Journal de Médecine Vétérinaire et de Zootechnie. Lyons, 1877.

"3. These ordinary and constant effects are not the only ones produced by the injection of the vaccine virus into the connective tissue. In the equine species, and particularly young animals, there sometimes occur magnificent pustular eruptions, which, in their seat and general characteristics, differ in nothing from natural Horse-pox. These vaccinal eruptions have never been observed in the experiments on the bovine species, though they were numerous, and made under those conditions which are reputed to be the most favourable to the development of the so-called "spontaneous Cow-pox." These eruptions have never been witnessed in experiments on man, though it must be confessed that the number of these was small.

"But the negative results in the human and bovine species do not authorise the conclusion that these are refractory to the manifestation of the vaccinal eruption in the before-mentioned conditions. But they demonstrate this important fact, that, so far as aptitude for the development of this exanthem is concerned, the organism of the horse possesses an incontestable superiority.

"4. This superiority is equally manifest, whether the vaccine virus is introduced directly into the lymphatic or blood-vessels, or enters by the natural channels of absorption. The intra-venous injection of vaccine matter—the most certain and easiest of these experiments—does not appear capable of producing vaccinal immunity in bovine animals. But in the horse not only does it ensure this immunity, but it often produces the vaccinal exanthemata which are an exact facsimile of those of the natural disease.

"5. The results of this experimental study show as well, if not better, than clinical observation, that the horse has a special aptitude for the natural or spontaneous development of Vaccinia, either under the influence of occult contagia, or by the problematical intervention of some other equivalent cause which has yet to be ascertained. The bovine species is far from manifesting such an aptitude for the evolution of natural Vaccinia. It might even be asserted that, in this respect, the ox is not superior to the human species—at least it is certain that the inferiority of the latter has not been demonstrated.

"From this study it is evident—and the evidence is further fully confirmed by clinical facts—that the organism of the horse is the real source (*vraie patrie*) of natural Vaccinia, conformably to the views of Jenner."

Chauveau notes in the course of his remarks, that if the other supposed vacciniferous animals—the goat, sheep, dog, etc.—show more or less distinct eruptions when they are vaccinated, the virus cannot be indefinitely cultivated on them; it loses its activity very rapidly, often in the first generation.

With regard to the protective influence of one attack of Variola from subsequent attacks, there can be no doubt; and this protection has been sought for, with a view to preventing the more serious Variolæ of certain species of animals, by inoculating them with the virus of a less malignant Variola of another species. But here, again, we find evidence in support of our view, that every species has its own particular Variola. Human Small-pox, readily communicated from a diseased to a healthy person, can scarcely be trans-

mitted, if at all, to the lower animals ; while Horse-pox and Cow-pox are easily transmissible to a number of species, and in man and the horse and cow, when inoculated, will certainly ensure against the natural disease. But we have seen that Sheep-pox is not communicable to other animals (if we except the few, and not very reliable, instances recorded), and that vaccination will not protect ovines from their special Variola.

But it must be confessed that experimental pathology has here an almost virgin soil to cultivate ; for, in reality, we know but little of the degree of inter-communicability of the different Variolæ, or of the protection they mutually afford against each other's operation. The subject is full of interest, and of the deepest importance to mankind, and that it has been so utterly neglected is one of the mysteries which overhangs many other serious problems in pathology.

I trust that the grave fallacy that Vaccinia is only human Variola modified by transference to bovines, will no more be heard of ; and that the claims of comparative pathology to recognition as a worthy helpmate to human pathology in the elucidation of this and other subjects in medicine, may be conceded and acted upon.

ADDENDUM.

ANIMAL VACCINATION.

The subject of animal or retro-vaccination—*i.e.*, inoculating bovines with humanised vaccine lymph, and employing the product in vaccinating people again—is at the present moment receiving much attention ; and notwithstanding the discussion which has taken place, and the conclusions arrived at with regard to it, it may be suitably and profitably alluded to here in connection with this study.

It would appear that Duquenelle, of Rheims, was the first to attempt the transference of humanised vaccine to its original source, the cow, with the view of obtaining a renewed supply of lymph for vaccination purposes, though others state it was Sacco. Husson soon afterwards had a marked success in Paris, the two cows which he had vaccinated furnishing a plentiful supply of improved lymph.*

The veterinarians, Hering (of Stuttgart) and Numan (of Utrecht) were also successful in this retro-vaccination ; both, from their experiments, showing that the humanised lymph was revived, and that the cow was very susceptible to the action of the vaccine virus. Numan further asserted that the bull is as susceptible as the cow, and that the horse and ass are equally susceptible, though the action of the virus re-transferred from the two latter to man, is slower in producing the usual phenomena. In 1836, Bousquet discovered a case of original Cow-pox in a cow at Passy, from which the dairy-maid had been accidentally inoculated. He vaccinated a number of people from this cow, and observed that the operation of the virus was slower and at the same time quicker than the ordinary humanised vaccine : slower in

* “*Recherches Historiques et Médicales sur la Vaccine.*” Paris, 1801.

that its action was more prolonged, while vesicles were larger, flatter, more brilliant and umbilicated, firmer, and altogether better defined. Whereas the humanised vaccine gave rise to a pock which became desiccated after the seventh or eighth day, that from this cow, on the contrary, produced vesicles which increased to twice the size of the others, and re-vaccinations with the old lymph, and even Small-pox matter, had subsequently no effect on the persons so inoculated.

From that time to the present, attention has been directed to the cow, either as a source of original virus, or that from which an increased quantity might be obtained by retro-vaccination when the ordinary supply was insufficient to meet the demand, or when this had become deteriorated in activity or quality. With this object in view, Negri, at Naples, has for many years resorted to what is designated "animal vaccination," and from him Lacroix received Cow-pox lymph with which he has inoculated heifers for a long time at Paris, and so furnished a notable quantity of lymph for the vaccination of people. At Bâle, Switzerland, Siegmund cultivated the virus on bulls intended for slaughter, preferring the scrotum for inoculation; but succeeding cultivators, who appeared in almost every European country, have usually preferred female calves, selecting the inferior part of the abdomen, especially between the teats, where the skin is thin and fine, and less likely to be injured by contact.

Chauveau has been successful in producing a fine vaccinal eruption in inoculating either cows, calves, or even bulls and horses, with humanised vaccine lymph, or that derived from Horse-pox; and when people were vaccinated with matter from this eruption, the pocks were slow in evolution, but attained extraordinary dimensions. Each time that he injected the vaccine virus into a lymphatic or blood-vessel, the subcutaneous connective tissue, or the respiratory mucous membrane—in fact, introducing it into the economy by any other channel than the skin, he produced a generalised eruption of Vaccinia. This was effected quite independently of the quantity of virus employed, so long as it was appreciable, and also independently of sex—male animals exhibiting the eruption as readily as females; though age had a manifest influence, young animals being much more disposed to the action of the virus than old ones. But this generalised Vaccinia did not appear to afford any better protection than the local eruption produced by inserting the virus into the derm, its *germination sur place*, indicated by the formation of a pustule at the seat of inoculation, exercising on the entire organism quite as marked influence; for after the fifth day it was impossible to produce an effect on any part of the skin by subsequent inoculations.

The question whether and to what extent disease may be transmitted from one human being to another by vaccination—through the medium of the vaccine lymph transferred from a vaccinated person—I do not intend to discuss here. It may be sufficient to state that the evidence is strongly in favour of such transmission, and that the occurrence of serious mishaps in this respect has been one of the reasons for resorting to the so-called animal vaccination. It now concerns us to know if there is any likelihood of animal

disorders being communicated to mankind in the process of re-vaccinating from animals, or using matter from spontaneous or original Cow-pox.

The two species of animals which might be employed to furnish new or renewed vaccination lymph, are the bovine and equine (perhaps also the asinine). The first-named is that generally preferred, and therefore we will deal with it first.

The diseases or morbid conditions of the bovine species which may be considered worthy of consideration in connection with animal vaccination, are : 1. Contagious Pleuro-pneumonia ; 2. Foot-and-Mouth Disease ; 3. Anthrax ; 4. Septicæmia and Pyæmia ; 5. Erysipelas ; 6. Tuberculosis.

1. *Contagious Pleuro-pneumonia* is a specific, most frequently chronic, disease of bovines. Inoculation with the serum from diseased lungs produces local, and generally most extensive and serious lesions, of a similar character to those observed in the lungs of accidentally affected animals, though experimental inoculation does not give rise to the specific Pneumonia. Though very infectious, and readily inoculable in the bovine species (one attack or successful inoculation protecting), yet the disease has never been accidentally or experimentally transmitted to other species. There is no recorded instance of the transmission of this malady to man, notwithstanding its great prevalence in nearly every part of the world for very many years. Young and adult animals alike suffer when infected. I am strongly of opinion that no danger is to be apprehended from the presence of the disease in cattle affected with original or transmitted Vaccinia, so far as employing lymph for vaccination purposes is concerned. The existence of the disorder is chiefly indicated by increase of temperature, quickened respiration, painful and short dry cough, and modified pulmonary sounds heard on auscultation.

2. *Foot-and-Mouth Disease* is another malady of bovines ; but, unlike the last-mentioned affection, it may be transmitted to a number of species, either accidentally or experimentally. It is communicable to mankind, usually through the medium of the milk from diseased cows. This milk has often a very pernicious, even fatal, effect on calves ; and it may, judging by analogy, be equally injurious to young children. But cutaneous inoculation is very rare in the human species, and when it does occur is not serious.

The eruption in bovines appears in the mouth and on the feet, and in some cases on the mammæ, where it might be mistaken by unskilful persons for Cow-pox. There is elevated temperature, the eruption and pain in the feet and mouth, the profuse salivation, and the prevalence of the disorder among a number of animals or over a wide extent of country, to guide the practitioner in distinguishing this affection from Vaccinia.

3. *Anthrax*—a multiform disease—due to the presence of a special kind of minute organism in the blood (the *Bacillus anthracis*), merits but little notice with regard to animal vaccination. It prevails in certain localities more particularly, and is so rapidly fatal that its existence quickly attracts attention. It is readily transmissible by inoculation, but the symptoms are so marked and rapid in their course, and the superficial emphysematous

swellings are so conspicuous, that it is scarcely possible to escape detection, or to have accidents arise through vaccine inoculation.

4. *Pyæmia and Septicæmia* are morbid conditions not very unfrequently seen in cattle. In the calf they are sometimes present as a result of inflammation of the umbilical cord, while in more adult animals they in some instances manifest themselves after parturition, as a sequel of Metritis. Their occurrence in the calf is of some moment with respect to vaccination. The symptoms are always high temperature, much general disturbance, swollen joints, stiff or painful movements, etc. Therefore, calves should be carefully examined, thermometrically and otherwise, and cows which have recently calved should also be inspected in order to discover whether they are free from Endo-metritis, commonly designated Puerperal Fever.

5. *Erysipelas* is a rare malady in cattle, and when it does appear is generally exogenous. It has only been seen in calves, I believe, after inoculation with humanised vaccine lymph, which had probably undergone changes through bad preservation. And when Erysipelas in children has followed inoculation with calf lymph, this has also, in all likelihood, been due to the same cause.

6. *Tuberculosis* is a readily inoculable disease, and has been produced experimentally in a somewhat wide range of species, by the milk, flesh, and tuberculous matter derived from diseased cows. It is analogous to, or identical with human Tuberculosis. It is infectious, and when generalised, the blood, secretions, lymph and flesh are viruliferous. In bovines it is a chronic disease, but in the porcine species when inoculated (it is not seen in this species under other circumstances), it assumes the acute form. As the pig is closely allied to man in organisation, this feature is worthy of consideration.

The malady is seldom seen in calves, or cattle under two years of age ; though as it is a chronic disease, they may nevertheless be infected.* But it is very questionable if cutaneous inoculation alone would produce the disease ; as hitherto, in experimenting, subcutaneous inoculation has always been practised. Nevertheless, it is advisable that great care be exercised in excluding calves which have a tuberculous or scrofulous taint, or even any history of these in their pedigree.

These are the chief morbid conditions of bovines which may be considered in relation to animal vaccination. Human Syphilis has never been transmitted to any animals accidentally ; and only by experiment has it been conveyed to monkeys. Bollinger states that cattle have been employed to desyphilize human vaccine lymph, and in no instance has it been found to affect them perniciously ; nor has such lymph when inoculated again in man been known to convey Syphilis.

The horse is not likely to be employed for vaccination purposes ; therefore

* For a study of this subject, see my articles in the *British and Foreign Medico-chirurgical Review* for October, 1874 ; the *VETERINARY JOURNAL* for May, 1880 ; *Veterinary Sanitary Science and Police*, vol. ii., p. 368 ; and pamphlet, "Tuberculosis from a Sanitary and Pathological Point of View," 1880

I need not allude to the diseases of this animal which are transmissible to man by inoculation. Glanders is the most notable, and the most to be dreaded, and as it is often very difficult to diagnose, the greatest circumspection would require to be observed.

In animal vaccination, it is obvious that every precaution should be taken to ensure the production of the purest lymph possible. Not only should everything be ascertained with regard to the source of the animals employed, but a most careful examination should be made of each, and particularly with the thermometer. If the temperature is above the normal standard, the animal should not be inoculated, or if successfully inoculated, the lymph should not be used. Young animals should be preferred, as not only are they more susceptible and easily inoculated, but they are more likely to be exempt from transmissible diseases, especially those of a chronic nature. If killed soon after being used for the production of lymph, their carcasses ought to be examined to ascertain their soundness before the lymph is employed for vaccination purposes. Great care ought to be observed in taking the lymph, and its decomposition should be guarded against, so as to prevent septic infection. Lymph carefully and quickly dried is safer than moist lymph. Purulent lymph should never be employed, as it will probably give rise to suppurative vaccination.

Though retro-vaccination may be approved as a means of revivifying or purifying humanised lymph, yet it is obvious that the preference should always be given to the lymph obtained from cases of so-called "spontaneous" or "original Cow-pox," or even Horse-pox. With our advancing knowledge of the intimate nature of contagia, it is quite possible that in a short time the specific organisms of vaccine lymph, or even Small-pox lymph, will be cultivated in such a manner, without the intervention of the living body, that inoculation with them will ensure a maximum of protection from Variola, with a minimum of danger to the inoculated.

Experiments in this direction are now being pursued with vaccine lymph, and also with that of Sheep-pox, and a few months will probably decide whether this simple and safe method will really prove successful.

